

**Report of the United States Section  
International Boundary and Water Commission**



**Deliveries of Waters  
Allotted to the United States  
Under Article 4 of the United States – Mexico  
Water Treaty of 1944**

**April 2002**

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The 1944 Water Treaty delimits the rights of the two countries with respect to the waters of the Colorado and Tijuana Rivers, and of the Rio Grande from Fort Quitman, Texas, to the Gulf of Mexico. Article 4 of the 1944 Water Treaty specified the allocation between the United States and Mexico of the waters of the Rio Grande. This report outlines the rights granted to the United States, as well as actions taken by Mexico in implementation of its obligations, under Article 4, paragraph B, of the 1944 Water Treaty, and provides a review of the actions taken by the United States Section of the International Boundary and Water Commission (US Section of the IBWC) concerning the application and exercise of U.S. rights under Article 4. Attached to this report, as a technical annex, is a report prepared by the U.S. Section with technical assistance from R.J. Brandes Company of Austin, Texas, which provides hydrologic, climatologic, reservoir storage data, and rainfall runoff quantities made available to the United States in the Mexican portion of the Rio Grande Basin covering the period from October 1992 through September 30, 2001.

**Authority**

The 1944 Water Treaty entrusts to the International Boundary and Water Commission (IBWC) the application of the treaty, the regulation and exercise of the rights and obligations assumed by the Governments of the United States and Mexico under this treaty, and the settlement of all disputes that may arise from the observance and execution of this treaty.<sup>1</sup>

**Rights Assumed by the United States**

The United States Government has a right in accordance with the 1944 Water Treaty to a portion of waters from six named Mexican Rio Grande tributaries (Treaty Tributaries) under certain conditions. Subparagraph (c) of Article 4 of the 1944 Treaty provides as follows:

“One-third of the flow reaching the main channel of the Rio Grande (Rio Bravo) from the Conchos, San Diego, San Rodrigo, Escondido and Salado Rivers and the Las Vacas Arroyo, provided that this third shall not be less, as an average amount in cycles of five consecutive years, than 350,000 acre-feet<sup>2</sup> (431,721,000 cubic meters) annually....”

The same subparagraph limits the United States right to the stipulated volume but allows the use by the United States of a portion of the flows in excess of that volume:

“The United States shall not acquire any right by the use of the waters of the tributaries named in this subparagraph, in excess of the said 350,000 acre-feet

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<sup>1</sup> Article 2, United States – Mexico Treaty for Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, signed February 3, 1944, entered into force November 8, 1945.

<sup>2</sup> The IBWC performs the joint water accounting in metric units; for the purpose of this report, a conversion factor of 0.81071 is multiplied times thousands of cubic meters to arrive at acre-feet.

(431,721,000 cubic meters) annually, except the right to use one-third of the flow reaching the Rio Grande (Rio Bravo) from said tributaries, although such one-third may be in excess of that amount.”

Article 4, in its next to last paragraph, considers that there may be times when Mexico would have difficulty in making the referenced flows available:

“In the event of extraordinary drought or serious accident to the hydraulic systems on the measured Mexican tributaries, making it difficult for Mexico to make available the run-off of 350,000 acre-feet (431,721,000 cubic meters) annually, allotted in subparagraph (c) of paragraph B of this Article to the United States as the minimum contribution from the aforesaid Mexican tributaries, any deficiencies existing at the end of the aforesaid five-year cycle shall be made up in the following five-year cycle with water from the said measured tributaries.”

Article 4, provides that, after the United States and Mexico construct the international dams<sup>3</sup> called for under the treaty, should the waters assigned to U.S. ownership exceed the storage capacity in the international dams at any point during the course of a five-year cycle, that cycle will terminate and all debts will be cancelled.

“Whenever the conservation capacities assigned to the United States in at least two of the major international reservoirs, including the highest major reservoir, are filled with waters belonging to the United States, a cycle of five years shall be considered as terminated and all debits fully paid, whereupon a new five-year cycle shall commence.”

### **Water Deliveries 1953 – 1968**

The first international storage dam on the Rio Grande, Falcon Dam, was placed in operation in October 1953. Following the beginning of operation of the second international storage dam, Amistad Dam, in 1969, the United States and Mexico agreed in IBWC Minute No. 234 to begin the accounting of the waters of the Rio Grande allotted to the United States from the six named Mexican tributaries, effective from October 1, 1953.

This resulted in the close of the first cycle of five consecutive years on September 30, 1958 with a deficit of 476,461 acre-feet<sup>4</sup> owed to the United States under Article 4, Paragraph B. The volume equivalent to one-third of the flows from the six Treaty Tributaries arriving in the Rio Grande in the next cycle of five consecutive years was in excess of the annual average of 350,000 acre-feet or a five year total of 1,750,000 acre-feet. That excess volume was more than

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<sup>3</sup> Article 5 of the 1944 Treaty authorized the United States – Mexico construction of “The dams required for the conservation, storage and regulation of the greatest quantity of the annual flow of the river in a way to ensure the continuance of existing uses and the development of the greatest number of feasible projects, within the limits imposed by the water allocations specified.” In furtherance of this provision, the IBWC constructed the international Falcon Dam (1953) and Amistad Dam (1969).

<sup>4</sup> An acre-foot is the volume of water that would cover an acre of land by one foot, or 326,000 gallons. The IBWC accounts for the international waters using metric measure. Using this system, one cubic meter is equivalent to 0.81071 acre-feet.

sufficient to cover the water delivery deficit owed to the United States from the previous five-year cycle. The third five-year accounting cycle closed on September 30, 1968 with a volume of 32,270 acre-feet in excess of 1,750,000 acre-feet obligation. Table 1 provides the accounting by the United States and Mexico of the waters of the Rio Grande from the Treaty Tributaries allotted to the United States under paragraph B of Article 4 of the 1944 Water Treaty.

### **Agreement for Deficit Coverage**

IBWC Minute No. 234 also addressed the manner in which Mexico could make up a deficiency in waters owed to the United States under Article 4, paragraph B. At the time IBWC Minute No. 234 was concluded Mexico had completed construction of Luis L. Leon Dam on the Conchos River, approximately 200 river miles from its confluence with the Rio Grande. This dam and others on the Conchos River provides to Mexico infrastructure to capture flood flows that otherwise would go uncontrolled to the Rio Grande. Minute No. 234 establishes:

“That in the event of a deficiency in a cycle of five consecutive years from the said tributaries, the deficiency shall be made up in the following five-year cycle, together with any quantity of water which is needed to avoid a deficiency in the aforesaid following cycle, by one or a combination of the following means:

- a. With water of that portion of the said tributary contributions to the Rio Grande allotted to the United States in excess of the minimum quantity guaranteed by the Water Treaty;
- b. With water of that portion of said tributary contributions to the Rio Grande allotted to Mexico, when Mexico gives advance notice to the United States and the United States is able to conserve such waters;
- c. By transfer of Mexican waters in storage in the major international reservoirs, as determined by the Commission, provided that at the time of the transfer, United States storage capacity is available to conserve them.

Following approval of both governments, Minute No. 234 entered into force as an agreement between the United States and Mexico on December 2, 1969.

### **Water Deliveries 1968 – 1992**

The next accounting period after the close of the last five-year cycle accounting period in Minute No. 234, ended on August 21, 1972 when the conservation capacities assigned to the United States in the international Falcon and Amistad Reservoirs filled with waters belonging to the United States. As noted above, under the 1944 Water Treaty, a five-year cycle is terminated and any debits that exist at the end of that cycle are fully paid when these conditions occur. Operation of Amistad Dam began in 1969. The accounting of waters from the Treaty Tributaries allotted to the United States between 1968 and 1992 is shown at Table 2.

### **Water Deliveries 1992-1997**

During the period between October 1, 1992 and September 30, 1997, Mexico delivered a total of 726,151 acre-feet toward fulfillment of its obligation under Article 4, Paragraph B. This resulted in a deficit from that cycle of 1,023,849 acre-feet of water owed to the United States.

### **Water Debt Coverage 1997-2000**

In late 1997, the U.S. Section of the IBWC requested agreement of the Mexican Section of the IBWC (Mexican Section) on the volume in deficit and application of provisions in IBWC Minute No. 234 for coverage of the deficit with waters from Mexico's portion of the Treaty Tributaries and the transfer to U.S. ownership of Mexican-owned water in storage at the international Falcon and Amistad Reservoirs. Following internal consultations, the Mexican Section, in March 1998, agreed on the volume in deficit but advised that Mexico would cover the deficit with water from Treaty Tributaries, should that volume be greater than an annual volume of 1,050,000 acre-feet. The U.S. Section in April 1999 objected to the proposal and urged application of the Minute No. 234 provisions for debt coverage with Mexican waters and requested a technical meeting with the Mexican water authorities, in the context of recent agreements that Mexico provide more detailed information concerning conditions in the Treaty Tributary basins.<sup>5</sup> During a technical meeting in 1999, Mexico informed that extraordinary drought conditions had made it difficult for Mexico to provide the runoff and reiterated to cover the deficit when excess flows became available. Mexico stated that the Rio Conchos Basin reservoirs were at 26 percent of conservation capacity and the reservoirs in the Salado Basin, the larger of the Treaty Tributary Basins, was at 11% of storage capacity. Mexico reported lower than normal precipitation for the 1993 – 1998 period.

The U.S. Section requested more detailed information but observed in late 1999, that based upon the limited information Mexico had provided, there appeared to be an opportunity for Mexico to operate its Treaty Tributary reservoirs in a manner that would allow application of the provisions of Minute No. 234 relating to debt coverage with Mexican owned waters. Further, the U.S. Section observed that storage of Mexican owned waters at the international reservoirs was such that there was also an opportunity for Mexico to transfer ownership of some of those waters to the United States as provided under Minute No. 234. Finally, the U.S. Section observed that water deliveries made to date in the current cycle were significantly below the annual average obligation of 350,000 acre-feet and urged the operation of Mexico's Treaty Tributary reservoirs in a manner that targets the United States allotment. At technical meetings in early 2000, Mexico informed that the deficit could only be covered in the event of excess flows, but agreed to an emergency release of waters from the Rio Conchos to increase Mexican storage at the international dams where the waters could be transferred to U.S. ownership.

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<sup>5</sup> IBWC Minute No. 293, "Emergency Cooperative Measures to Supply Municipal Needs of Mexican Communities located along the Rio Grande Downstream of Amistad Dam," signed October 4, 1995 in Mexico City and entered into force November 8, 1995, provides that "The Commission will continue its practice of exchanging information regarding water management practices by competent water agencies in the two countries in the interest of having basin-wide information that will enable the proper authorities in the two countries to have the best information possible in developing conservation and other planning strategies in the part of the Rio Grande basin in their respective territories."

The U.S. Section in March 2000, reiterated its call for immediate agreement on a good faith implementation plan of immediate water releases from the Rio Conchos and parallel mid and longer term planning efforts designed to cover the deficit and to target the U.S. allocation in future years. In tandem with these efforts, the United States Department of State initiated a series of demarches with the Mexican Foreign Ministry in which it urged Mexico to honor its treaty obligations to the United States. In response, the Mexican Section agreed in March 2000 to transfer ownership of 137,821 acre-feet from international storage to the United States and to temporarily assign its 50% share of the unmeasured tributary flows in the Rio Grande reach between Fort Quitman and Falcon Dam to U.S. ownership.<sup>6</sup> These actions were intended to provide to the United States the minimum annual average of 350,000 acre-feet and an additional volume, which the U.S. Section considered as a total target goal of 400,000 acre-feet for the water year of October 1, 1999 through September 30, 2000. This volume coincided with the request of Texas irrigators.

At the close of the third year of the present five-year accounting cycle, that is from October 1, 1997 – September 30, 2000, Mexico had delivered a total of 407,087 acre-feet. The prior cycle deficit and the current cycle obligation totaled 1,381,362 acre-feet as of September 30, 2000 as can be observed in Table 3.

### **U.S. Allocation Target Framework Talks 2001**

In June 2001, the IBWC opened discussions concerning a framework that Mexico could adopt with respect to management of its Treaty Tributary reservoirs that would target the annual United States allotment as a high national priority. However, these discussions were deferred in order to develop a water delivery plan for the period from October 1, 2000 – September 30, 2001.

### **Minute No. 307 Water Deliveries**

In August 2000, the U.S. Section pressed the Mexican Section to release more water from storage in Luis L. Leon Reservoir on the Rio Conchos and Venustiano Carranza Reservoir on the Rio Salado; resume technical discussions on watershed conditions; continue assignment of Mexico's allocation of the unmeasured tributary waters to the U.S.; and adopt a framework for Treaty Tributary reservoir operations that would target the annual obligation to the United States as a high national priority. Mexico agreed to release water from Luis Leon Reservoir and Venustiano Carranza Reservoir, of which one-third would be allotted to the United States and agreed as well to the limited assignment of its portion of the unmeasured tributary waters to the United States. In the months that followed, the U.S. Section urged Mexico to commit to providing 600,000 acre-feet of water to the United States between October 1, 2000 and September 30, 2001. President Bush reinforced this need at his meeting with Mexican President Vicente Fox on February 28, 2001 in Guanajuato, Mexico. IBWC negotiations resumed in Washington under the auspices of the Department of State and resulted in the conclusion of

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<sup>6</sup> Paragraph A, subparagraph d, of Article 4 of the 1944 Water Treaty allots to Mexico, "One-Half of all other flows not otherwise allotted by this Article occurring in the main channel of the Rio Grande (Rio Bravo), including the contributions from all the unmeasured tributaries, which are not named in the Article, between Fort Quitman and the lowest major international storage dam."

IBWC Minute No. 307.<sup>7</sup> Under Minute No. 307, Mexico and the United States agreed to a framework of actions by Mexico committed to ensure that 600,000 acre-feet of water would be provided to the United States by September 30, 2001, at the latest, based on runoff scenarios described in the agreement. Under Minute No. 307, the United States and Mexico also agreed to continue discussions within the IBWC to arrive at additional measures concerning the prior cycle deficit and the current cycle obligation by December 2001. Finally, Minute No. 307 called for cooperation by the two Governments concerning drought management and sustainable management of the Rio Grande basin from Fort Quitman to Falcon Dam.

By February 2002, Mexico had been credited with delivering 427,544 acre-feet of the 600,000 acre-feet it had ensured that it would provide under Minute No. 307. This leaves a shortfall of 172,446 acre-feet. The expected volumes and actual deliveries are presented in Table 5.

From October 1, 1997 – September 30, 2001, Mexico delivered a total of 427,544 acre-feet. As of September 30, 2001, the prior cycle deficit and the current cycle obligation totaled 1,303,819 acre-feet of water owed to the United States, as can be observed in Table 3.

### **Current Situation**

The U.S. Section on a number of occasions since October 2001 has asserted its concerns to Mexico that the terms of Minute No. 307 have not been fully met and has requested technical talks to arrive at a remedy for the Minute No. 307 shortfall and a water delivery plan for the current year as required under Minute No. 307. The Department of State has likewise urged Mexico to conduct immediate technical talks within the IBWC toward resolution of this matter. President Bush raised the outstanding deficit in waters owed to the United States during his bilateral meeting with President Fox at Monterrey March 22, 2002 and urged immediate water deliveries to the United States toward fulfillment of Mexico's treaty obligation. The Mexican Government continues to assert that it does not have sufficient water under current climatic conditions to make additional water deliveries to the United States.

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<sup>7</sup> IBWC Minute No. 307, "Partial Coverage of Allocation of the Rio Grande Treaty Tributary Water Deficit from Fort Quitman to Falcon Dam," signed March 16, 2001 in Washington, entered into force as an agreement between the United States and Mexico by exchange of diplomatic notes March 16, 2001.

Table 1

**International Boundary and Water Commission  
Accounting of Waters from the Conchos, San Diego, San Rodrigo,  
Escondido, Salado Rivers and the Las Vacas Arroyo  
Allotted to the United States  
1953 – 1968  
(in acre-feet)**

Period	Waters Arriving in Rio Grande	One-third Allotment to United States	Excess or Deficiency in United States Allotment
Oct 1, 1953 To Sep 30, 1958	3,820,619	1,273,539	(476,461)
Oct 1, 1958 To Sep 30, 1963	6,894,550	2,298,184	548,184
Oct 1, 1963 To Sep 30, 1968	5,346,810	1,782,270	32,270

**Table 2**  
**FIVE-YEAR CYCLE BEGINNING AND ENDING DATES**  
**(U.S. Interpretation unless otherwise noted)**

BEGIN	END	Volume Delivered	
		Acre-Feet	TCM
OCT. 1, 1953	SEPT. 30, 1958	Per Minute No. 234	
OCT. 1, 1958	SEPT. 30, 1963	Per Minute No. 234	
OCT. 1, 1963	SEPT. 30, 1968	Per Minute No. 234	
OCT. 1, 1968	AUG. 21, 1972	2,230,967	
MAY 13, 1973	AUG. 3, 1973	112,725	
OCT. 19, 1973	SEPT. 20, 1974	289,688	
OCT. 8, 1975	JULY 15, 1976	277,638	
OCT. 14, 1976	DEC. 8, 1976	122,116	
JUNE 9, 1977	NOV. 6, 1978	861,484	
NOV. 7, 1978	NOV. 16, 1978	38,014	
AUG. 3, 1979	SEPT. 7, 1979	7,403	
SEPT. 22, 1979	JUNE 11, 1981	840,763	
AUG. 6, 1981	SEPT. 3, 1981	51,393	
OCT. 1, 1981	OCT. 11, 1981	20,857	
OCT. 14, 1981	OCT. 26, 1981	37,900	
OCT. 27, 1981	MAY 31, 1982	221,718	
JUNE 15, 1982	JUNE 23, 1987	1,582,251	
JUNE 29, 1987	AUG. 2, 1987	91,095	
AUG. 9, 1987	AUG. 31, 1987	44,669	
NOV. 8, 1987	SEPT. 29, 1988	450,347	
OCT. 22, 1988	NOV. 2, 1991	1,873,034	
NOV. 8, 1987	SEPT. 29, 1988	450,347	
OCT. 22, 1988	NOV. 2, 1991	1,873,034	
NOV. 5, 1991	DEC. 18, 1991	24,975	
JULY 15, 1992	JULY 23, 1992	33,600	
SEPT. 2, 1992	SEPT. 26, 1992	26,707	
OCT. 3, 1992	OCT. 2, 1997 **	724,272	
OCT. 3, 1997			

Periods not shown indicate that the U.S. share of assigned conservation in Amistad and Falcon were full.

All cycles ended due to filling of U.S. normal or temporary conservation capacity in both Amistad and Falcon Reservoirs except those indicated by\*\*.

By agreement\*

**Table 3**  
**Current Five Year Cycle**  
**Deliveries and Accumulated Deficit**  
**October 3, 1997 – April 6, 2002**  
**In Acre-feet (af)**

<b>Period</b>	<b>Treaty Tributaries</b>	<b>Unmeasured Tributaries</b>	<b>Storage Transfer</b>	<b>Total</b>	<b>Accumulated Total</b>	<b>Accumulated Deficit</b>
<b>Oct 3, 1992 – Oct 2, 1997 Deficit</b>	726,151			726,151	726,151	1,023,849
<b>Oct 1, 1997 – Sep 30, 1998</b>	120,283			120,283	120,283	1,253,564
<b>Oct 1, 1998 – Sep 30, 1999</b>	165,117			165,117	285,400	1,438,447
<b>Oct 1, 1999 – Sep 30, 2000</b>	105,720	163,547	137,821	407,088	692,488	1,381,362
<b>Oct 1, 2000 – Sep 30, 2001</b>	125,376	302,168	0	427,544	1,120,032	1,303,819
<b>Oct 1, 2001 – April 6, 2002</b>	7,912	0	0	7,912	1,127,944	1,476,181

**Table 4**  
**Minute No. 307 Deliveries**  
**October 1, 2000 – September 30, 2001**  
**(in acre-feet)**

Period	Treaty Tributaries		Unmeasured Tributaries		Upstream Storage		Cumulative Delivered Based on preliminary accounting
	Consider	Deliver	Consider	Deliver	Consider	Deliver	
Oct 1, 2000 – Mar 3, 2001							203,736
Mar 4, 2001 – July 31, 2001		13,189		72,017	38,103*	21,504	312,959
Aug 1, 2001 – Sep 30, 2001	64,046 to 84,314	27,160	159,710 to 239,159	89,938	Volume to arrive at 600,000**	0	427,544

\* One third of 138,631 af to be released from Carranza Dam

\*\* Released from four dams in treaty tributaries.

## **TECHNICAL ANNEX**

**Update of the Hydrologic, Climatologic, Storage and  
Runoff Data for the United States  
In the Mexican Portion of the Rio Grande Basin:  
October 1992-September 2001**



**April 2002**

**prepared by**

**United States Section  
International Boundary and Water Commission**

**with technical assistance from**

**R.J. Brandes Company  
Austin, Texas**

## **Preface**

This report was prepared by the United States Section, International Boundary and Water Commission (IBWC) to provide an update of hydrologic, climatologic, reservoir storage levels and rain runoff quantities in the Mexican portion of the Rio Grande Basin covering the period from October 1992 through September 2001. The data is presented in the general format as that presented in a preliminary report developed by the R.J. Brandes Company of Austin, Texas in February 2000.

The data presented in this report was obtained from the joint records of the United States and Mexican Sections of the IBWC and from Mexico's National Water Commission during technical information exchange meetings conducted by the IBWC and from a field observation meeting hosted by Mexico on September 10-13, 2001. The joint IBWC records contain both final and preliminary water accounting. Final accounting is considered by the IBWC to be quality checked by both Sections of the IBWC. Preliminary accounting is that which the IBWC considers is subject to a final determination by the IBWC in behalf of the United States and Mexico. The IBWC does not make joint determination of data provided by the National Water Commission.

The report is intended to provide data to the general public and is not in any way intended to represent a position of the United States Government concerning differences that have arisen in the application of Article 4 of the 1944 Water Treaty under which the United States assumed the right to a part of the waters from certain Rio Grande tributaries in Mexico.

## **Update of the Hydrologic, Climatologic, Storage and Runoff Data for the United States in the Mexican Portion of the Rio Grande Basin: October 1992 - September 2001**

The Rio Grande forms the international border between the United States and Mexico for over 1,200 miles along the state boundary of Texas, extending from the Gulf of Mexico upstream to above the City of El Paso. The ownership of water flowing between the United States and Mexico in the Rio Grande below Fort Quitman, Texas, is determined by the United States – Mexico Treaty for Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, signed on February 3, 1944 (1944 Water Treaty). The joint accounting of that ownership is performed by the International Boundary and Water Commission (IBWC). The reach of the Rio Grande below Fort Quitman is identified on the map of the Rio Grande Basin in Figure 1<sup>1</sup>. Of the total productive drainage area of the Rio Grande below Fort Quitman (144,400 square miles), approximately 60 percent lies within Mexico.

Of the portion of the basin in Mexico, the 1944 Water Treaty allots to the United States:

“One third of the flow reaching the main channel of the Rio Grande from the Conchos, San Diego, San Rodrigo, Escondido and Salado Rivers and the Las Vacas Arroyo provided that this third shall not be less, as an average amount in cycles of five consecutive years, than 350,000 acre-feet (431,721,000 cubic meters) annually. The United States shall not acquire any right by the use of the waters of the tributaries named in this subparagraph, in excess of the said 350,000 acre-feet (431,721,000 cubic meters) annually, except the right to use one-third of the flow reaching the Rio Grande from said tributaries, although one-third may be in excess of that amount.”<sup>2</sup>

These six Mexican tributaries (Treaty Tributaries) are denoted on the map of the lower portion of the Rio Grande Basin in Figure 2. Together these tributaries contribute inflows to the Rio Grande from about 53,450 square miles of the drainage area. The remaining 32,550 square miles of drainage area in Mexico is in tributaries whose inflows to the Rio Conchos are totally assigned to Mexico notably the Rio San Juan, Rio Alamo. The Rio Conchos, which is the farthest upstream and the largest, drains a total of about 26,400 square miles, and enters the Rio Grande above Big Bend National Park and upstream of Amistad Reservoir. Las Vacas Arroyo and the Rios San Diego, San Rodrigo and Escondido all enter the Rio Grande between Amistad and Falcon Reservoirs. These tributaries are relatively small and drain a total of about 3,730 square miles. The Rio Salado flows into the Rio Grande just below Falcon Reservoir and has a drainage area of about 23,320 square miles.

The terrain of these Mexican tributary basins typically range from relatively flat plains to rolling hills along the Rio Grande, to small mountain ranges up to about 6,000 feet in elevations in the upper portions of the watersheds. The region is arid to semi-arid, with annual rainfall amounts ranging from about 14 inches up to about 20 inches. The higher rainfall amounts generally occur

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<sup>1</sup> Figures and Tables are included at the end of this report.

<sup>2</sup> Paragraph B, subparagraph (c) of Article 4, 1944 Water Treaty

in the higher elevations. Streamflows in these tributaries are predominantly runoff-based, and extreme low flows can occur during prolonged dry periods. However, when rainfall does occur within these watersheds, even for short duration storm events, significant amounts of runoff can be produced and provide substantial inflows to the Rio Grande. The monthly variation of the total contribution of inflows to the Rio Grande from these six Mexican tributaries since the 1950's is illustrated by the graph in Figure 3.

Mexico assumed the obligation to make runoff from the Treaty tributaries available to the United States under conditions established in the 1944 Water Treaty. Under these terms, Mexico may incur a debt in a five year accounting cycle but must cover the deficit in the next accounting cycle:

“In the event of extraordinary drought or serious accident to the hydraulic systems on the measured Mexican tributaries, making it difficult for Mexico to make available the runoff of 350,000 acre-feet (431,721,000 cubic meters) annually, allotted in subparagraph (c) of paragraph B of this Article to the United States as the minimum contribution from the aforesaid Mexican tributaries, any deficiencies existing at the end of the aforesaid five-year cycle shall be made up in the following five-year cycle with water from the said measured tributaries.”<sup>3</sup>

In furtherance of this provision, the IBWC, in 1969, adopted Minute No. 234 as a means in which Mexico would make up in the next five-year cycle, any deficiency occurring in a five-year cycle.<sup>4</sup>

The 1944 Water Treaty also covers the beginning and ending of a cycle. This occurs when the capacity assigned to the United States at the Amistad and Falcon international reservoirs are filled with United States waters. Amistad and Falcon Dams were designed, constructed and are operated and maintained by the IBWC on behalf of both countries, effective in 1953 and 1969, respectively, under the 1944 Water Treaty. The 1944 Water Treaty provides:

“Whenever the conservation capacities assigned to the United States in at least two of the major international reservoirs, including the highest major reservoir, are filled with waters belonging to the United States, a cycle of five years shall be considered as terminated and all debits fully paid, whereupon a new five-year cycle shall commence.”<sup>5</sup>

The last time that this occurred was on October 2, 1992. A new accounting cycle began on October 3, 1992, and continued for five consecutive years through October 2, 1997. The current five-year accounting cycle began on October 3, 1997, and is in its fifth and final year.

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<sup>3</sup> Penultimate paragraph of Article 4 of the 1944 Water Treaty.

<sup>4</sup> Resolution 2 of IBWC Minute No. 234, “Waters of the Rio Grande Allotted to the United States from the Conchos, San Diego, San Rodrigo, and Salado Rivers and the Las Vacas Arroyo,” signed December 2, 1969

<sup>5</sup> Last paragraph of Article 4 of the 1944 Water Treaty.

## WATER DELIVERIES

Records are published annually by the IBWC regarding historical flows in the Rio Grande and its major tributaries<sup>6</sup>. Streamflow gages are maintained near the mouth of the Treaty Tributaries. Following are periods of continuous daily flow records for these six gages:

Rio Conchos near Ojinaga, Chihuahua	April 1954 to Present
Arroyo de las Vacas at Cd. Acuna, Coahuila	January 1938 to Present
Rio San Diego near Jimenez, Coahuila	October 1932 to Present
Rio San Rodrigo at El Moral, Coahuila	January 1962 to Present
Rio Escondido at Villa de Fuente, Coahuila	October 1932 to Present
Rio Salado near Las Tortillas, Tamaulipas	September 1953 to Present

The IBWC adopted October 1, 1953, as the date to initiate United States – Mexico accounting of the waters of the Treaty Tributaries in an international agreement in 1969.<sup>7</sup> Based on the above historical streamflow records, the annual Treaty Tributary inflows since 1954 are plotted on the bar chart in Figure 4. As shown, the one-third of the amounts of inflows arriving in the Rio Grande which are credited to the United States, have varied significantly, with inflows in some years being substantially above 350,000 acre-feet and in others being significantly below that amount. Based on the water-year annual tributary inflows plotted in Figure 4, the average annual inflow allotted to the United States during the 48-year period from October 1953 through September 2001 has been approximately 405,000 acre-feet. That same agreement memorialized the accounting for the first three five-year accounting cycles through September 30, 1968.<sup>8</sup> This action established that the first cycle ended with a deficit of 476,461 acre-feet, a deficit that was covered in the next accounting cycle. The next deficit occurred at the close of the accounting cycle ending October 2, 1997. That cycle ended with a deficit of 1,023,849 acre-feet.

Annual inflows to the Rio Grande from the Treaty Tributaries in the prior and current five-year accounting cycles are plotted on the bar chart in Figure 5.<sup>9</sup> Also shown on the chart for each of the accounting years are the calculated inflow volumes and the volume in debit when the annual amount is less than the minimum United States allotment of 350,000 acre-feet. The volumes in debit range in magnitude from approximately 53,300 acre-feet during the 1992-1993 accounting year to approximately 290,200 acre-feet during the 1995-1996 accounting year. The cumulative annual inflows for the four accounting years in the current cycle, shown on the chart, totals to a difference of 879,500 acre-feet from the cumulative average annual U.S. allotment volume of 350,000 acre-feet.

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<sup>6</sup> International Boundary and Water Commission, United States and Mexico; “Flow of the Rio Grande and Related Data, from Elephant Butte Dam, New Mexico to the Gulf of Mexico – 1998” Water Bulletin No. 68 (and prior years); United State Section, El Paso, Texas and Mexican Section, Ciudad Juarez, Chihuahua; 2000.

<sup>7</sup> Resolution No. 1 of IBWC Minute No. 234.

<sup>8</sup> Resolution No. 3 of IBWC Minute No. 234.

<sup>9</sup> These annual inflows are based on the sum of monthly inflows for the 12-month periods extending from October 1 of one year through September 30 of the following year. The resulting annual inflow amounts are approximately equal to the annual inflows corresponding to actual accounting years as defined by IBWC for the previous and current five-year accounting cycles, i.e., from October 3 of one year through October 2 of the following year.

The volumes in Figure 5 are only for inflows that arrive to the Rio Grande from the Treaty Tributaries and do not reflect volumes, totaling 603,536 acre-feet, that Mexico provided in the 1999-2000 and 2000-2001 accounting years. In 1999-2000, the IBWC transferred to United States ownership 137,821 acre-feet of waters belonging to Mexico at the international Amistad and Falcon reservoirs and temporarily assigned to the United States 163,547 acre-feet of Mexican waters from unmeasured tributaries to the Rio Grande in the reach from Fort Quitman, Texas to Falcon Dam (often referred to at “50/50” inflows because under the 1944 Water Treaty, unmeasured flows in this reach are allotted at 50 per cent to each country). In 2000-2001, the IBWC continued the assignment to the United States of the unmeasured tributary inflows which totaled 302,168 acre-feet.

These added volumes resulted in deliveries of 407,088 acre-feet in the 1999-2000 accounting year and 427,544 acre-feet in the 2000-2001 accounting year. At the close of the fourth year of the present five-year accounting cycle, that is from October 1, 1997 – September 30, 2001, prior cycle deficit and four years of the current cycle obligation totaled to 1,303,818 acre-feet.

## **MEXICAN TRIBUTARY RESERVOIRS**

Mexico has a number of reservoirs located on streams within the watersheds of Treaty Tributaries. These reservoirs are used to store water primarily for agricultural irrigation and to a lesser extent for municipal and industrial purposes. The smaller reservoirs provide limited storage capacity and are used primarily for regulating and diverting water released from the upstream larger reservoirs. One of the tributary reservoirs, Luis L. Leon, also includes storage capacity dedicated for flood control purposes.

Mexico operates these reservoirs in a manner that will first supply Mexico’s water upstream of the Rio Grande. Such flows that arrive to the Rio Grande are generally limited to releases of floodwater inflows to the Mexican reservoirs that are in excess of the reservoirs’ storage capacities and Mexico’s downstream demands in the lower part of the treaty tributaries.

The principal reservoirs located on the Treaty Tributaries are listed on Table 1 along with pertinent information, including their location by basin, stream and state; the year in which they were closed and their assigned conservation storage capacity. La Boquilla Reservoir on the Rio Conchos is the largest reservoir within the watersheds of the Treaty Tributaries. Other large reservoirs include Francisco I. Madero on the Rio San Pedro, Luis L. Leon on the lower Rio Conchos, San Gabriel on the Rio Florido, and Venustiano Carranza on the Rio Salado. As indicated in the table, the combined conservation storage capacity of all the tributary reservoirs is 4,408,983 acre-feet, of which a total of 4,253,813 acre-feet, or over 96 percent, is contained in the five larger reservoirs.

The approximate locations of the Mexican reservoirs on the Treaty Tributaries are shown on the map in Figure 6. With the exception of La Colina Reservoir, a small regulation impoundment on the Rio Conchos downstream from La Boquilla Reservoir, all of the Mexican

tributary reservoirs listed in Table 1 are identified on the map in Figure 6. Two of the smaller reservoirs, San Miguel and Centenario on the Rio San Diego, are identified with a symbol because of their proximate locations. As illustrated, most of the reservoir development has taken place in the Rio Conchos Basin, the largest of the six Treaty Tributaries.

Table 1 also presents information regarding Mexico's share of storage in the international Amistad and Falcon reservoirs on the Rio Grande. The combined conservation storage capacity assigned to Mexico in these two reservoirs is 2,478,952 acre-feet. This is about 56 percent of the combined storage capacity in Mexico Treaty Tributary reservoirs.

Mexico has advised that all of the reported conservation storage capacity in the Treaty Tributaries is less than indicated because sedimentation has significantly reduced the available storage capacity of the largest reservoirs. For example, the volume of accumulated sediment in Madero Reservoir is estimated to be 100 million cubic meters or about 81,071 acre-feet, which is almost 30 per cent of the reservoir's original conservation storage capacity. Mexico reports that the last sediment survey of Madero Reservoir was conducted in 1986. For La Boquilla Reservoir, the last sediment survey was in 1975. Mexico is in the process of either conducting or planning to conduct resurveys of these reservoirs to obtain more accurate data regarding their actual storage capacities.

The historical variation in the combined end-of-month storage in the five largest Mexican Rio Grande tributary reservoirs listed in Table 1 (La Boquilla, Madero, Luis L. Leon, San Gabriel and Carranza) is plotted in Figure 7 for the period covering the previous and current five-year accounting cycles (through December 2001). This data has been compiled from IBWC records and from information provided by Mexico. The changes in the monthly reservoir storage amounts indicated on the graph in Figure 7 reflect the net effects of the actual monthly inflows (runoff) to the reservoirs from their respective watersheds, less any monthly diversions or releases of water that were made from the reservoirs to meet irrigation, municipal and industrial demands. The reservoir storage amounts also reflect monthly losses from the reservoirs due to evaporation and seepage.

The reservoir storage plot in Figure 7 shows that there have been several periods during the previous and current five-year accounting cycles when there were substantial increases in storage in the reservoirs, which were a function of inflows. These storage increases reflect the inflows that remain after meeting downstream demands for irrigation, municipal and industrial uses in Mexico upstream of the Rio Grande. While increases in reservoir storage on the order of several hundred thousand acre-feet almost always have occurred during the late summer and fall months, particularly large increases in reservoir storage occurred during 1993, 1996 and 1999.

The corresponding total monthly inflows to the same five largest Treaty Tributary reservoirs for the period covering the previous and current five-year accounting cycles (through September 2001) are plotted on the graph in Figure 8. This inflow data, developed by Mexico, appear to be derived through water balance calculations based on monthly changes in reservoir storage, with adjustments for corresponding monthly evaporation losses and releases for downstream water users. The variations in inflows to the reservoirs generally track the changes

in total reservoir storage illustrated on the graph in Figure 7. The periods characterized by significant increases in reservoir storage are the same as those when the higher inflows occurred.

The cumulative inflows to the five largest Treaty Tributary reservoirs are plotted on the graph in Figure 8 for the period beginning in October of 1992. As shown, the total volume of inflows that entered these reservoirs during the previous and current five-year accounting cycles (through September 2001) was approximately 11.7 million acre-feet. In this period, Mexico released approximately 10.7 million acre-feet, primarily for irrigation in Mexico, and provided to the United States approximately 1,242,200 acre-feet from the Treaty Tributaries, or about 39 percent of the total obligation in nine consecutive years of 3,150,000 acre-feet.

A plot of total monthly inflows to the three Treaty Tributary reservoirs with the longest periods of record is presented at Figure 9. It is based on historical monthly inflow records dating to January 1949 for Boquilla and Madero Reservoirs on the Rio Conchos basin and Carranza Reservoir on the Rio Salado basin. For the 52-year period of record from October 1949 through September 2001, the average annual inflow to these three reservoirs, calculated based on water years, was approximately 1,608,000 acre-feet. For the nine-year period from October 1992 through September 2001, the average annual inflow to these three reservoirs was approximately 1,000,000 acre-feet, which is about 38 percent less than the long-term average inflow. For the October 1959 through September 1965 period, the average annual inflow to the reservoirs was approximately 1,099,000 acre-feet. The average annual inflow to the reservoirs for the eight-year period from October 1949 through September 1957 was approximately 823,000 acre-feet or about 49 percent less than the long-term average inflow. These three periods illustrated in Figure 9 indicate that the long term average inflows occurring in each of the last nine years are comparable to those in the 1959-1965 period, but are not as severe as during the 1947-1957 low inflow period.

On the Rio Conchos, at Luis L. Leon Reservoir, the lower most dam on that river, storage records show that the flood control capacity of some 400,500 acre-feet has at times been used to store flood inflows for several months before an evacuation of flood storage from this reservoir. A plot of the historical end-of-month storage in Luis L. Leon reservoir since October 2, 1967 is shown in Figure 10.

## **RAINFALL CONDITIONS IN TREATY TRIBUTARY BASINS**

Annual rain fall amounts for calendar years 1940 through 1999 were provided in an analysis performed by Mexico's National Water Commission from as many as 92 rainfall stations located within the Treaty Tributary watersheds.

Mexico's analysis provided for each calendar year during the 1993-1999 period the average annual rainfall for the Rio Conchos Basin, the Rio Grande Basin between Amistad and Falcon Reservoirs, and the Rio Salado Basin. The long-term average annual rainfall amounts for these watersheds also were determined using data for the entire periods of record for the 92 stations. The average length of the periods of record for these stations is 33 years.

The average annual rainfall quantities for the 1993-1999 period are plotted on the bar chart in Figure 11. As indicated on the chart, the overall average annual rainfall in the Rio Conchos Basin for the 1993-1999 period was 84.6 percent of normal. In the Rio Grande Basin between Amistad and Falcon Reservoirs, the corresponding average annual rainfall was 99.0 percent of normal, and in the Rio Salado Basin, it was 86.3 percent of normal. While this data indicate that below-average rainfall conditions (less than 100 percent of the long-term average annual rainfall amounts) occurred in each of the tributary watersheds during several of the years since 1993, the overall rainfall amounts in all of the basins generally were not appreciably below normal. Considering all of the stations in all of the watersheds, the average annual rainfall amount for the 1993-1999 period was over 90 percent of the long-term average amount.

A comparison of the annual quantities of water delivered to the United States from Treaty Tributary with corresponding annual average rainfall in these same watersheds as reported by Mexico is presented on the bar chart in Figure 12. This chart indicates the annual quantities of water that were delivered to the United States from the Mexican Treaty Tributaries during the 1980-1999 period as a percentage of 350,000 acre-feet annual United States allocation. Examination of this graph indicates that the annual rainfall amounts and patterns during the 1982-1985 period were very similar to those, which occurred during the more recent 1994-1997 period. However, as shown, the quantities of inflows delivered to the United States from the Mexican tributaries during these two periods were considerably different. During the 1982-1985 period, about 72 percent of the minimum allotment of 350,000 acre-feet per year was delivered, whereas during the 1994-1997 period, only about 30 percent was delivered.

Information available is not sufficient to determine the differences in the Treaty Tributary inflows that occurred in two separate periods where there were similar rainfall conditions. More information is needed concerning demands in Mexico and Mexico's reservoir operations during those two periods. The only treaty tributary reservoirs constructed by Mexico during this timeframe were Pico de Aguila Reservoir on the Rio Florido in the Rio Conchos Basin in 1993 and La Fragua Reservoir on the Rio San Rodrigo in 1990, both of which have relatively small storage capacities.

## **HISTORICAL MEXCAN WATER USE**

### **Treaty Tributary Irrigation Usage**

Practically all of the surface water used by Mexico from the reservoirs on these tributaries is used by downstream irrigation districts and a small portion of the water released is used for municipal and industrial purposes according to information provided by Mexico's National Water Commission.

The total annual releases from these reservoirs, based on water years beginning in October, 1980, are plotted on the bar chart in Figure 13. In the 1990's, Mexico apparently had been releasing on the order of two to three million acre-feet of water per year from these five Treaty Tributary reservoirs. Since about 1994, these releases have been substantially reduced as the available water supplies stored in these reservoirs have become limited.

Approximately 10.2 million acre-feet were released from the five largest treaty tributary reservoirs since the beginning of the previous five-year accounting cycle (Since October, 1992) through the fourth year of the current five-year accounting cycle (through September, 2001). This compares with approximately 11.7 million acre-feet of total inflows to these reservoirs (see Figure 8) and about 2.1 million acre-feet of total storage reduction (see Figure 7) over this same time period. The difference between the total available reservoir water supply reflected by the sum of the total inflows and the total storage reduction (13.8 million acre-feet) and the total releases (10.2 million acre-feet) represents the total evaporation and other losses from the reservoirs (3.6 million acre-feet).

As shown by the annual releases from the treaty tributary reservoirs in Figure 13, Boquilla Reservoir, which is the largest of the tributary reservoirs, has consistently released the most water. This reflects the significant use of water in the large irrigation district located downstream, referred to as the Delicias District. This district has supplied water from Boquilla Reservoir, as well as from Madero Reservoir. No releases, or at least very small releases, are indicated for some of the reservoirs in some of the drier years during the mid to late 1990's. This includes Madero Reservoir during the 1995 water year and Carranza Reservoir in water years 1996, 1997, 1999 and 2001. Only Boquilla Reservoir was used to supply irrigation water to the Delicias District during 1995, and no land was irrigated in the irrigation district below Carranza Reservoir in 1996, 1997, 1999 and 2001.

The large releases indicated for Luis L. Leon Reservoir reflect the discharge of excess flood waters, rather than irrigation releases, because, as discussed below, the historical amounts of water used for irrigation along the Lower Rio Conchos as reported by Mexico appear to have been considerably less than the relatively large quantities of water released from Luis L. Leon Reservoir. A comparison of the historical annual inflows to Luis L. Leon Reservoir and the corresponding annual releases from the reservoir is presented on the bar chart in Figure 14 for the period from 1981 through 2001 (by water years). As shown, the higher amounts of annual releases tend to track the higher quantities of inflows, which suggest that releases of water from Luis L. Leon Reservoir were made in excess of storage capacity downstream demands in the lower Rio Conchos, during excess flow periods.

It should also be noted that the reservoir release records from Mexico indicate that releases, in addition to those specifically for downstream users, have been made from Carranza Reservoir and from San Gabriel Reservoir. For Carranza Reservoir, these additional releases include 686,627 acre-feet in 1981; 345 acre-feet in 1982; 120,610 acre-feet in 1988; and 182,264 acre-feet in 1989. For San Gabriel Reservoir, they include 1,402 acre-feet in 1987; 16,470 acre-feet in 1988; 29,629 acre-feet in 1991; and 8,405 acre-feet in 1992. These additional releases, referred to as "controlled releases", occurred when the reservoirs were at or near their respective conservation storage capacities, and therefore, it is likely that these releases were comprised primarily of flood waters. These controlled releases have not been included in the annual release amounts plotted on the bar chart in Figure 13. As indicated above, there were no additional controlled releases reported for any of the tributary reservoirs during the drought of the 1990's.

Pertinent features and descriptive information regarding the various Mexican irrigation districts associated with different tributary reservoirs located in the Rio Grande Basin or with Amistad and Falcon Reservoirs on the Rio Grande are listed in Table 2. As indicated in the table, most of these irrigation districts have been in operation, to varying degrees, for many years, some since the 1930's. The first five of these irrigation districts (Nos. 005, 090, 103, 006 and 004) are located within the basins of the Treaty Tributaries. The other three irrigation districts listed in the table (Nos. 050, 026 and 025) are all located in the State of Tamaulipas proximate to the Rio Grande and receive their water supplies either directly from the Rio Grande or from other Mexican Rio Grande tributaries whose flows are allotted 100 percent to Mexico. Consideration of these other irrigation districts is important because their water supplies, like those for Texas water users in the Lower Rio Grande Valley, are directly impacted by reduced inflows to the Rio Grande from the six Mexican tributaries that also contribute water to the United States under the 1944 Treaty. The locations of all of these irrigation districts are noted on the map of the Mexican portion of the Rio Grande Basin in Figure 15.

The reservoirs that supply water to each of the irrigation districts are identified in Table 2. As noted, some of the districts are served by more than one reservoir. The general sizes of the irrigation districts also are indicated in Table 2 in terms of the maximum or average acreages of land within the districts that have been irrigated. The Delicias District (No. 005) in the Rio Conchos Basin, with over 300,000 acres under irrigation in 1987, is, by far, the largest district located within the six Treaty Tributary basins identified in the 1944 Treaty from which the United States receives one-third of the inflows to the Rio Grande. Of the other irrigation districts, the Lower Rio Bravo District in the State of Tamaulipas below Falcon Reservoir is the largest, with over 600,000 acres of land irrigated in 1993. As noted, many miles of canals, much of which are lined, have been constructed within the districts.

The principal crops grown in the irrigation districts in the Rio Grande Basin, where such data is available, is indicated in Table 3. Crops are grouped according to growing season, i.e., fall-winter, spring-summer, and perennials. As shown, all of these crop groupings are grown in the three districts located in the Treaty tributary basins (Nos. 005, 090 and 004); however, only the spring-summer crops are grown in the two irrigation districts located proximate to the Lower Rio Grande (Lower Rio Bravo and Lower Rio San Juan). The average acreages of these crop groupings also are shown for each district for years prior to 1992 and for the 1993-2000 drought period. As indicated, significant reductions in the acreages of crops grown have occurred during the current drought for all crop groupings in each of the district, except for the Lower Rio Conchos District downstream of Luis L. Leon Reservoir. In this district, only small reductions have occurred in the acreages of fall-winter and spring-summer crops, and the acreages of perennial crops actually have increased. Some of this increase is likely due to the conversion of high-dollar irrigated cropland to less productive irrigated pastures that are less expensive to grow and manage and less vulnerable to varying and uncertain water supplies.

Information regarding historical operations for several of the irrigation districts is summarized in Table 4. The information presented in Table 4 pertains to three of the irrigation districts within the treaty tributary basins and two of the other irrigation districts along the Lower Rio Grande in the State of Tamaulipas. Data is provided describing total acreages in agricultural

production within the districts, the irrigated portions of these acreages, and the volumes of water used for irrigation. As reported by Mexico, this data is presented as averages for years prior to and including 1992-2000 and as individual annual values for each year during 1993-2000 accounting cycles. The distinction between these two periods relates to the beginning of the previous five-year accounting cycle (October, 1992) when the current deficit initially began to accrue. As noted in the table, values of irrigation depths and application rates also have been calculated based on the reported acreages of irrigated area and the quantities of irrigation water used.

As expected, all of the irrigation districts for which data is presented in Table 4 experienced reductions in irrigated acreages during some years during the 1993-2000 accounting cycles. Reductions on the order of 70 to 80 percent occurred during a number of years, particularly during 1995, 1996, and 1997. As noted previously, one district, Don Martin downstream from Carranza Reservoir in the Rio Salado Basin, had no land under irrigation in 1996, 1997, or 1999<sup>10</sup>. The corresponding significant reductions in irrigation water usage during the drought years also are apparent in table 4.

The calculated irrigation application rates appear to include system losses due to seepage, evaporation, canal breaks, etc., and, therefore, may not accurately reflect the actual application of water on cropland. However, the average application rates for each of the three districts for the 1993-2000 period are actually slightly higher than the long-term average rates corresponding to the period prior to and including 1992.

Lower irrigation application rates characterize the two irrigation districts along the Lower Rio Grande in the State of Tamaulipas.

### **Rio Grande Municipal Usage**

Mexico indicated that it needs to maintain a reserve of at least 243,000 acre-feet (300 million cubic meters) of storage in the Amistad-Falcon reservoir system for it to meet the municipal water supply needs of demands of its Rio Grande communities.

The major Mexican municipal water users that rely on the Rio Grande and the Amistad-Falcon reservoir system for their water supplies include the cities of Ciudad Acuna, Piedras Negras, Nuevo Laredo, and Nueva Ciudad Guerrero, all located on the Rio Grande between Amistad and Falcon Reservoirs, and the cities of Ciudad Miguel Aleman, Ciudad Diaz Ordaz, Reynosa, Control-Valle Hermoso, and Matamoros, which are all located downstream of Falcon Reservoir proximate to the Lower Rio Grande. The demand for water by these municipalities has increased dramatically over the last few decades. This is illustrated by the bar chart in Figure 16 that shows the total annual quantities of water, by water years, that have been diverted from the Rio Grande for municipal use since 1960 by the cities between Amistad and Falcon Reservoirs. As indicated, these diversions have increased by a factor of about six over the last 40 years, and they presently are on the order of about 65,000 acre-feet per year.

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<sup>10</sup> Also, no land was irrigated in the Don Martin District in 2001.

Releases from Falcon Reservoir supply water to the municipalities located along the Lower Rio Grande, including the major cities of Reynosa and Matamoros. According to recent diversion records<sup>11</sup>, these municipalities are using a total of about 100,000 acre-feet of water per year from the Rio Grande.

Considering all of the major Mexican municipalities located on or near the Rio Grande below Amistad Reservoir, the current demand for municipal water is approximately 165,000 acre-feet per year. This one-year demand for municipal water represents about 68 percent of the 243,000 acre-foot reserve that Mexico has indicated it wants to maintain for municipal use in Amistad and Falcon Reservoirs.

### **Lower Rio Grande Irrigation Usage**

The Anzalduas Canal serves as the principal conveyance facility for the majority of Rio Grande water used by Mexico for irrigation downstream from Falcon Reservoir, including irrigation water for the Lower Rio Bravo District (No. 025). The headworks for the canal are at the Anzalduas Dam, located on the Rio Grande about 105 miles downstream of Falcon Dam. Water for the city of Matamoros also was conveyed through the Anzalduas Canal until a few years ago, when new pumping facilities were installed at Matamoros farther downstream on the Rio Grande.

Prior to the installation of the Matamoros pump plant, historical diversions into the Anzalduas Canal averaged slightly less than a million acre-feet per year<sup>12</sup>, but as illustrated by the bar chart in Figure 17 showing annual diversions since 1960<sup>13</sup>, the canal diversions have been significantly reduced since about 1995. The limited supply of water stored by Mexico in Amistad and Falcon Reservoirs has required that irrigation water usage in those districts that rely on the Rio Grande directly be substantially curtailed. These include primarily the Lower Rio Bravo and Lower Rio San Juan Districts (Nos. 025 and 026) in the State of Tamaulipas.

### **IN SUMMARY**

1. The deficit in quantities of inflows allotted to the United States from the Treaty Tributaries for the five-year accounting cycle ending October 2, 1997 was 1,023,849 acre-feet and at the close, on September 30, 2001, of the fourth year of the current accounting cycle, Mexico's total inflow deficit was 1,303,818 acre-feet.
2. During the previous five-year accounting cycle and the first four years of the current five-year accounting cycle (through September 30, 2001), the total volume of inflows to the five largest reservoirs on the Treaty Tributaries was approximately 11.7 million acre-feet.

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<sup>11</sup> International Boundary and Water Commission, United States and Mexico; "Flow of the Rio Grande and Related Data from Elephant Butte Dam, New Mexico to the Gulf of Mexico-1997 (and 1998)"; Water Bulletin Numbers 67 (and 68); United States Section, El Paso, Texas and Mexican Section, Ciudad Juarez, Chihuahua; 1999 (and 2000).

<sup>12</sup> For the period 1954 through 1995, the annual diversions into the Anzalduas canal averaged 985,900 acre-feet.

<sup>13</sup> It should be noted that the annual diversion amounts plotted in Figure 17 include some municipal water.

During this period, Mexico released approximately 10.2 million acre-feet from these reservoirs primarily for use in irrigation upstream of the Rio Grande and in part for evacuation of water from flood storage in Luis L. Leon Reservoir on the Rio Conchos. Some stored water also was released to the Rio Grande. During this nine-year period, Mexico provided approximately 1,242,200 acre-feet of inflows from the Treaty Tributaries.

3. Examination of rainfall data in the Treaty Tributaries indicate that the annual rainfall amounts and patterns that occurred between 1994 and 1997 were similar to those that occurred in 1982-1985, but the quantities in inflows from the Treaty Tributaries to the Rio Grande were considerably different in the two periods. More information is needed concerning water demands in Mexico and Mexico's reservoir operations during those two periods.
4. Since 1992, Mexico's total usage of surface water for irrigation from the reservoirs in the Treaty Tributaries has been significantly reduced in some years with the exception of the irrigation district below Luis L. Leon Reservoir which has experienced an increase relative to conditions prior to 1992. More information is needed on irrigation application rates and system losses.

## **FIGURES**

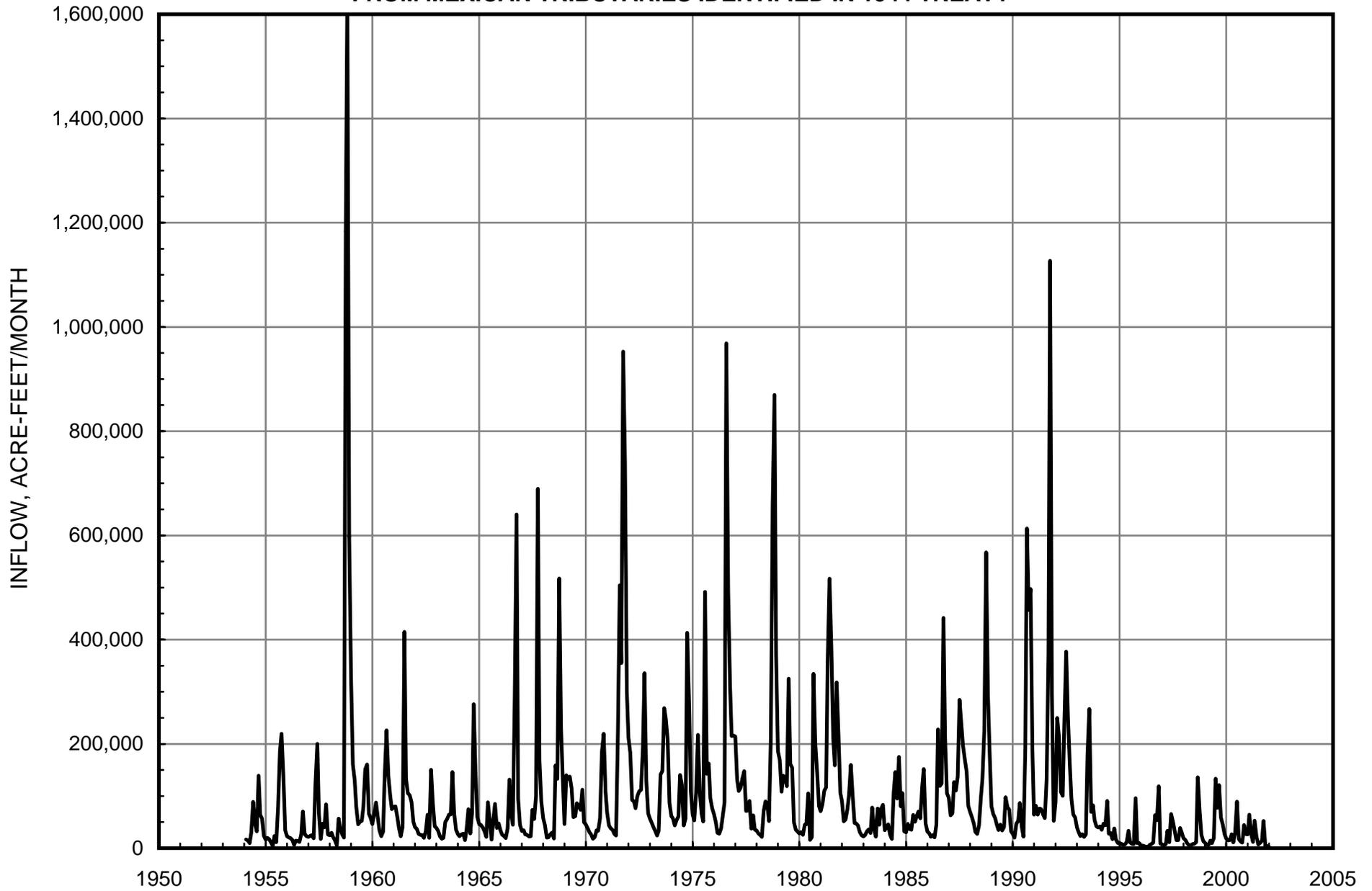
**FIGURE 1  
RIO GRANDE BASIN**



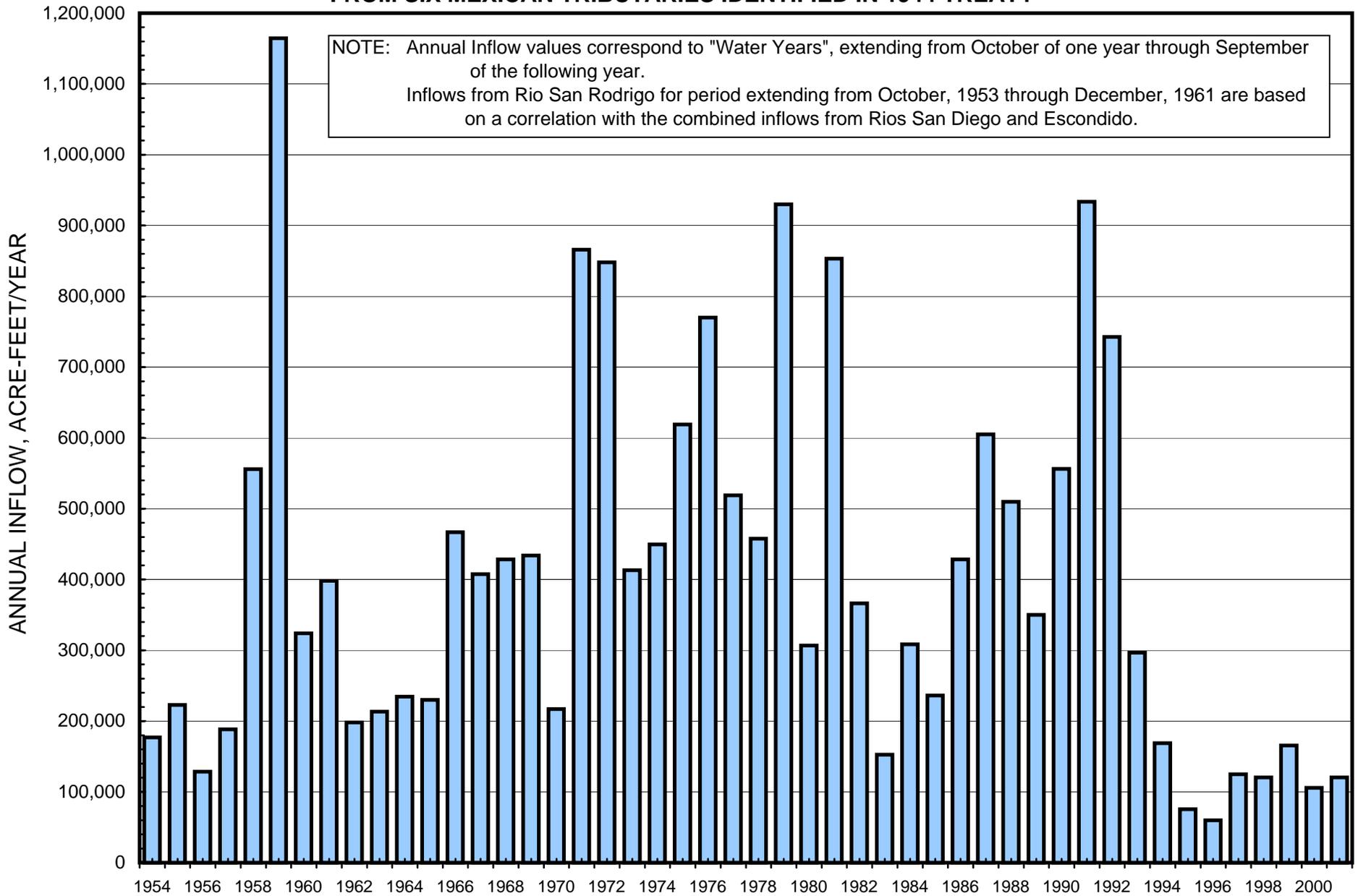
**FIGURE 2**  
**MEXICAN RIO GRANDE TRIBUTARIES IDENTIFIED IN 1944 TREATY**



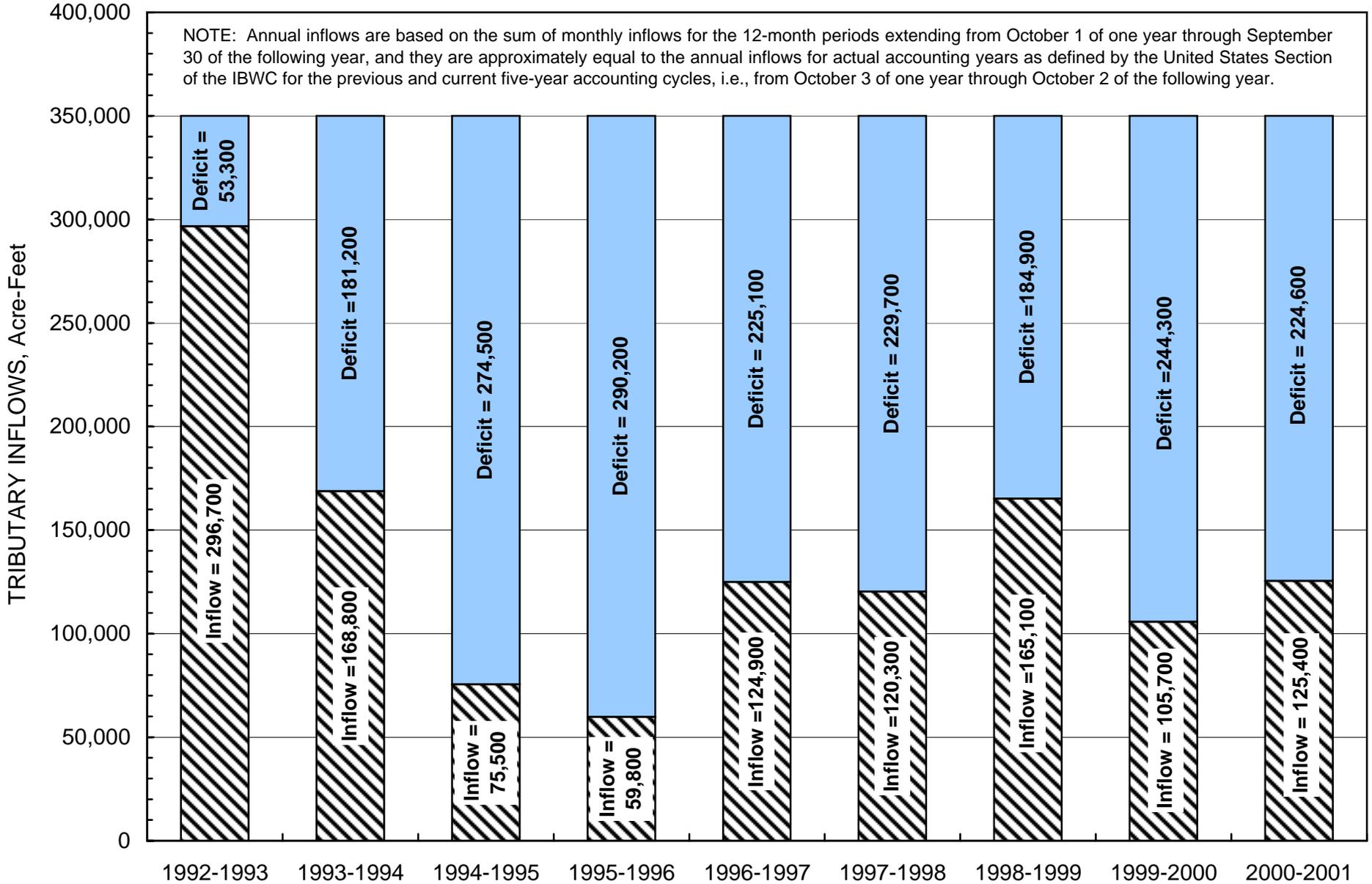
**FIGURE 3**  
**HISTORICAL MONTHLY TOTAL INFLOWS TO RIO GRANDE**  
**FROM MEXICAN TRIBUTARIES IDENTIFIED IN 1944 TREATY**



**FIGURE 4**  
**UNITED STATES PORTION OF HISTORICAL ANNUAL INFLOWS TO RIO GRANDE**  
**FROM SIX MEXICAN TRIBUTARIES IDENTIFIED IN 1944 TREATY**



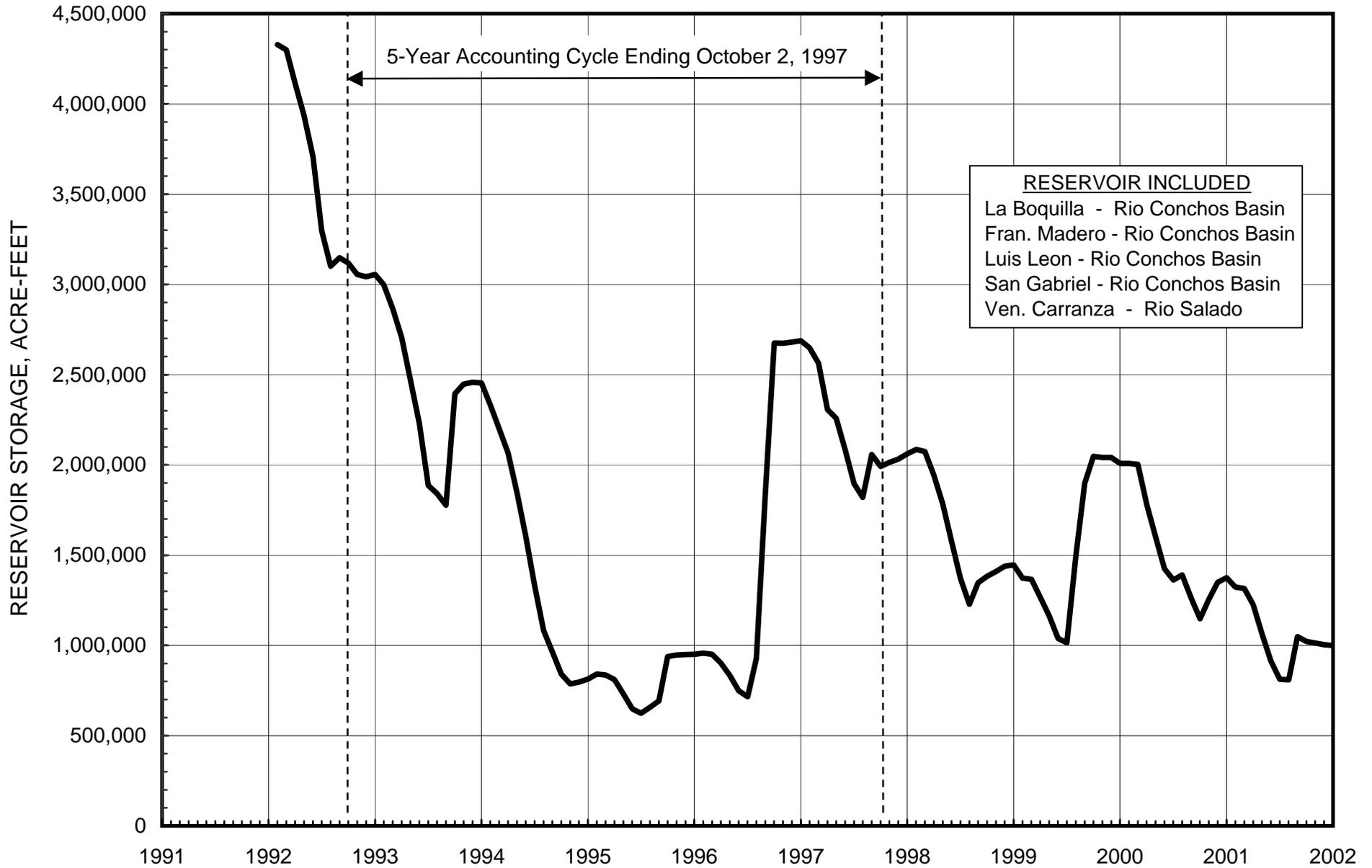
**FIGURE 5**  
**ANNUAL INFLOWS AND DEFICITS FOR MEXICAN TRIBUTARIES UNDER 1944 TREATY**  
**DURING PREVIOUS AND CURRENT FIVE-YEAR ACCOUNTING CYCLES**



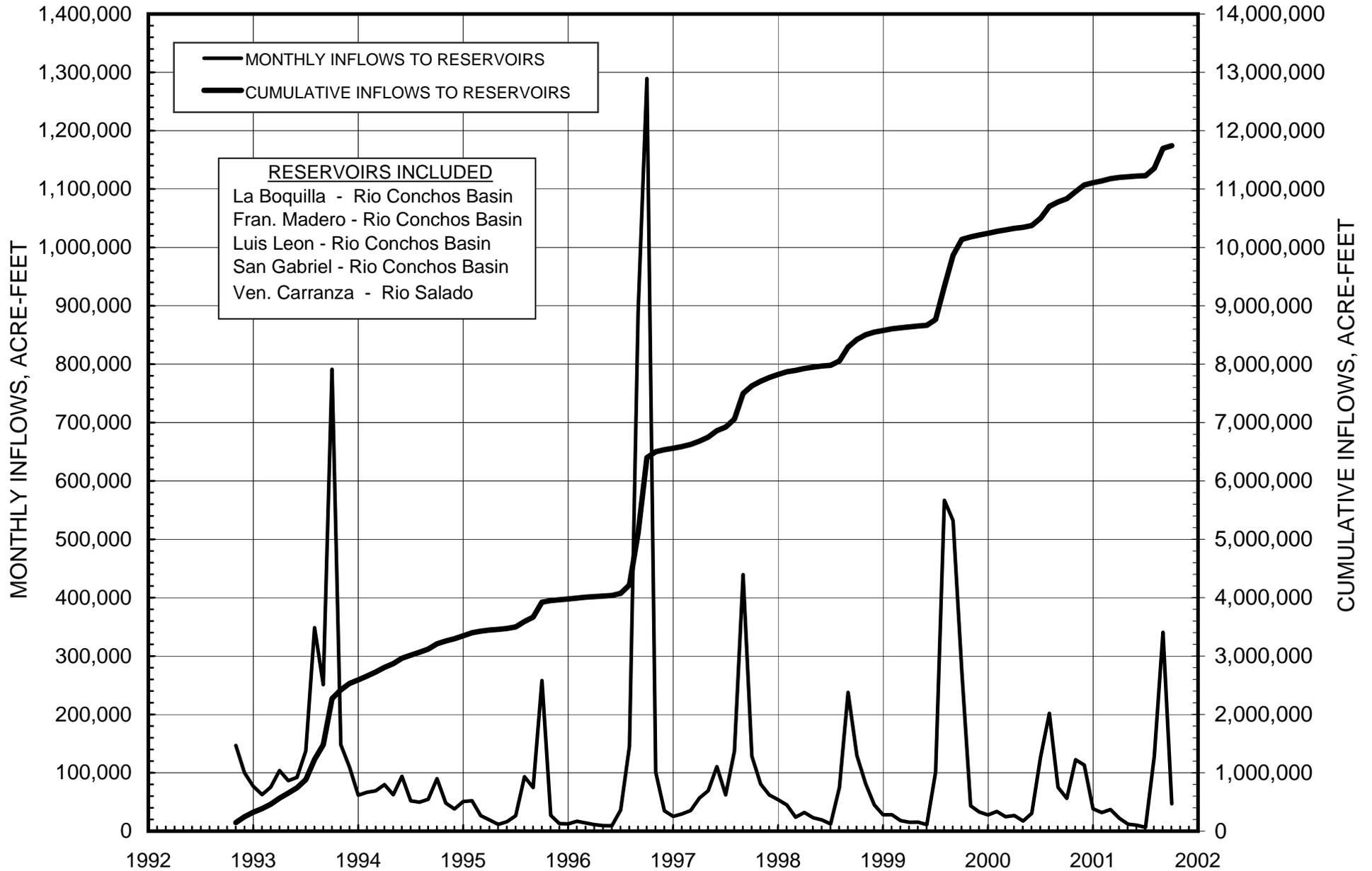
**FIGURE 6**  
**MAJOR MEXICAN RESERVOIRS LOCATED ON TRIBUTARIES IDENTIFIED IN 1944 TREATY**



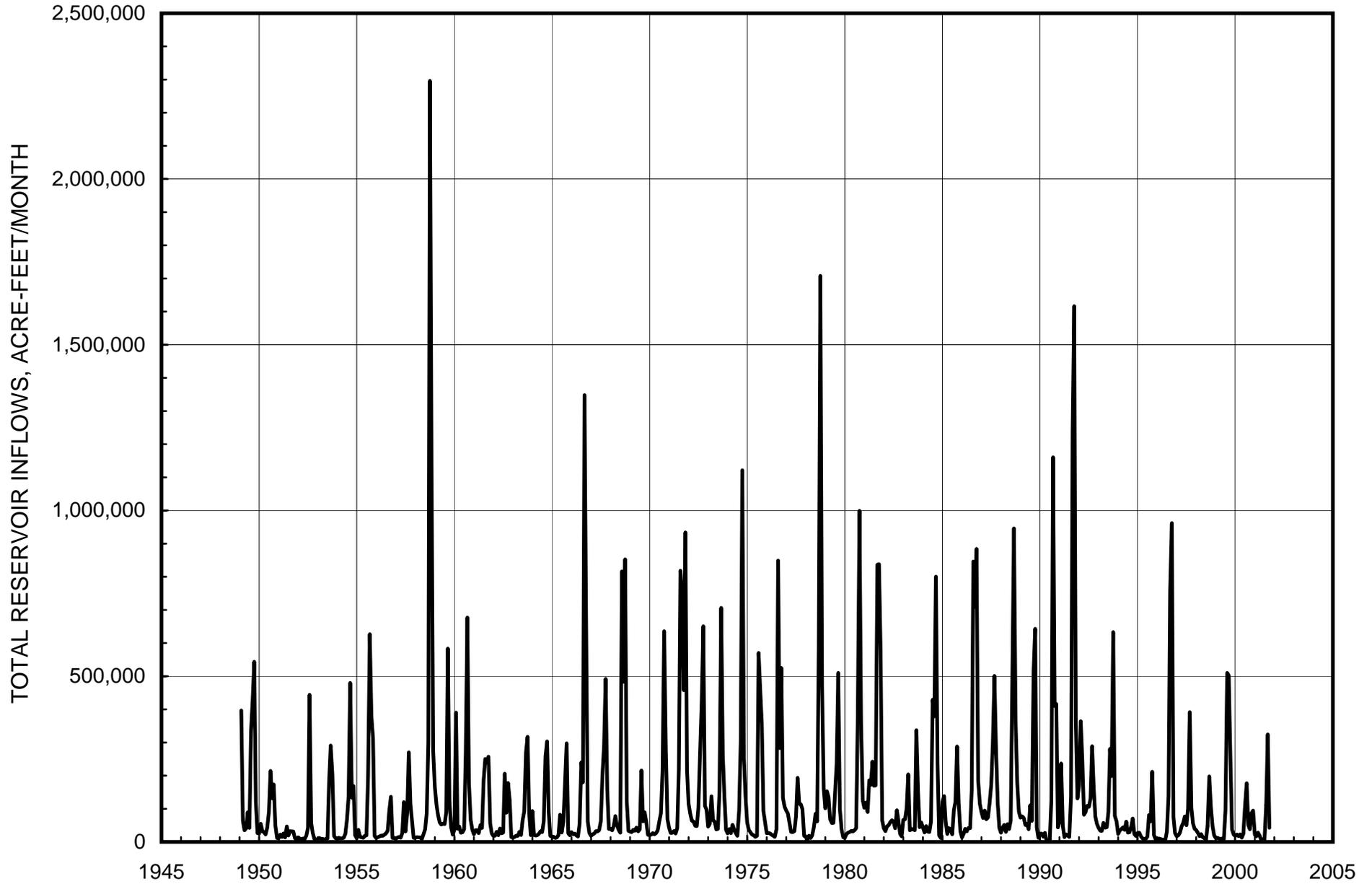
**FIGURE 7**  
**MONTHLY STORAGE DURING PREVIOUS AND CURRENT FIVE-YEAR ACCOUNTING CYCLES**  
**IN FIVE LARGEST RESERVOIRS ON MEXICAN TRIBUTARIES IDENTIFIED IN 1944 TREATY**



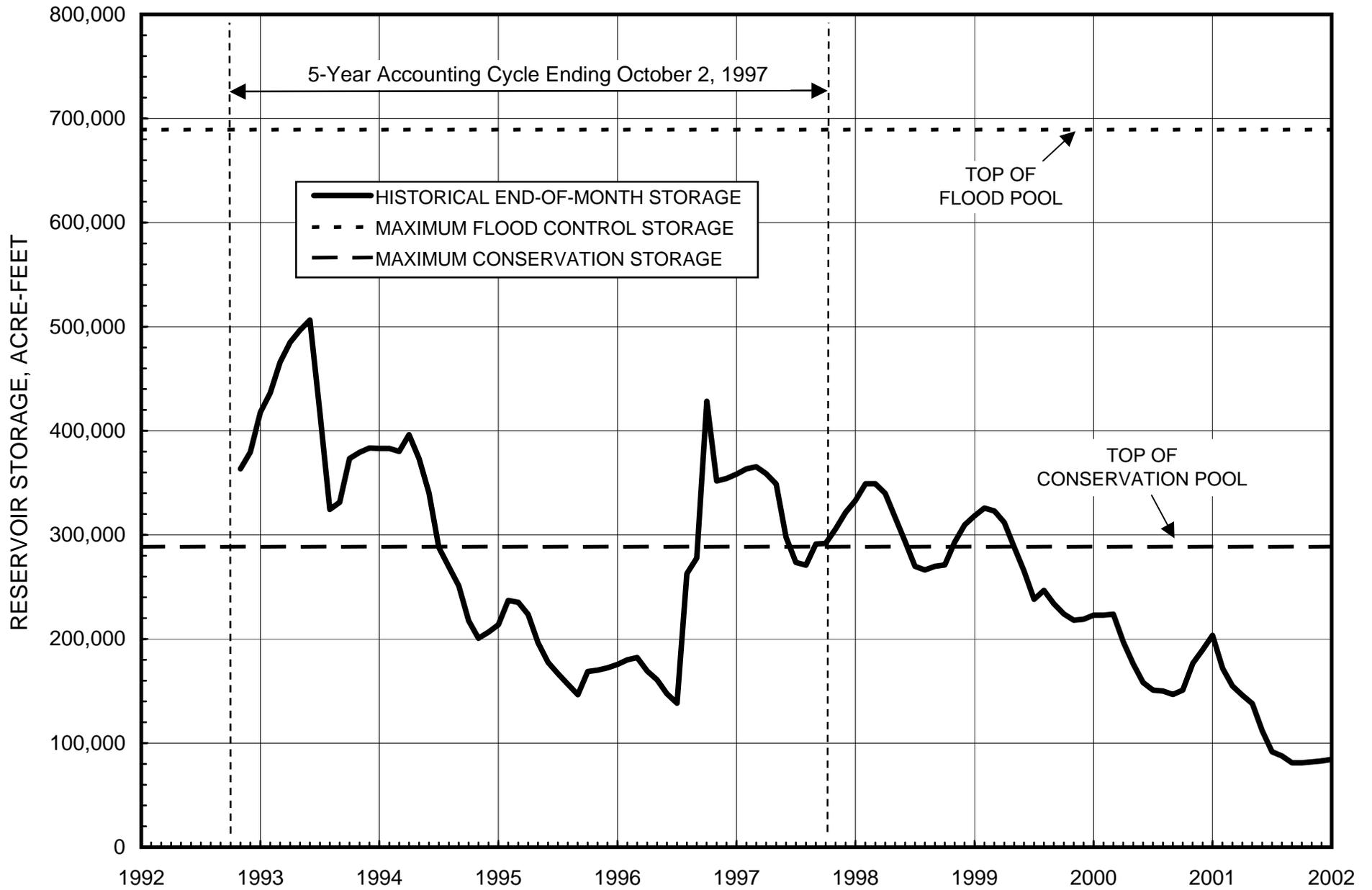
**FIGURE 8**  
**MONTHLY INFLOWS DURING PREVIOUS AND CURRENT FIVE-YEAR ACCOUNTING CYCLES**  
**TO FIVE LARGEST RESERVOIRS ON MEXICAN TRIBUTARIES IDENTIFIED IN 1944 TREATY**



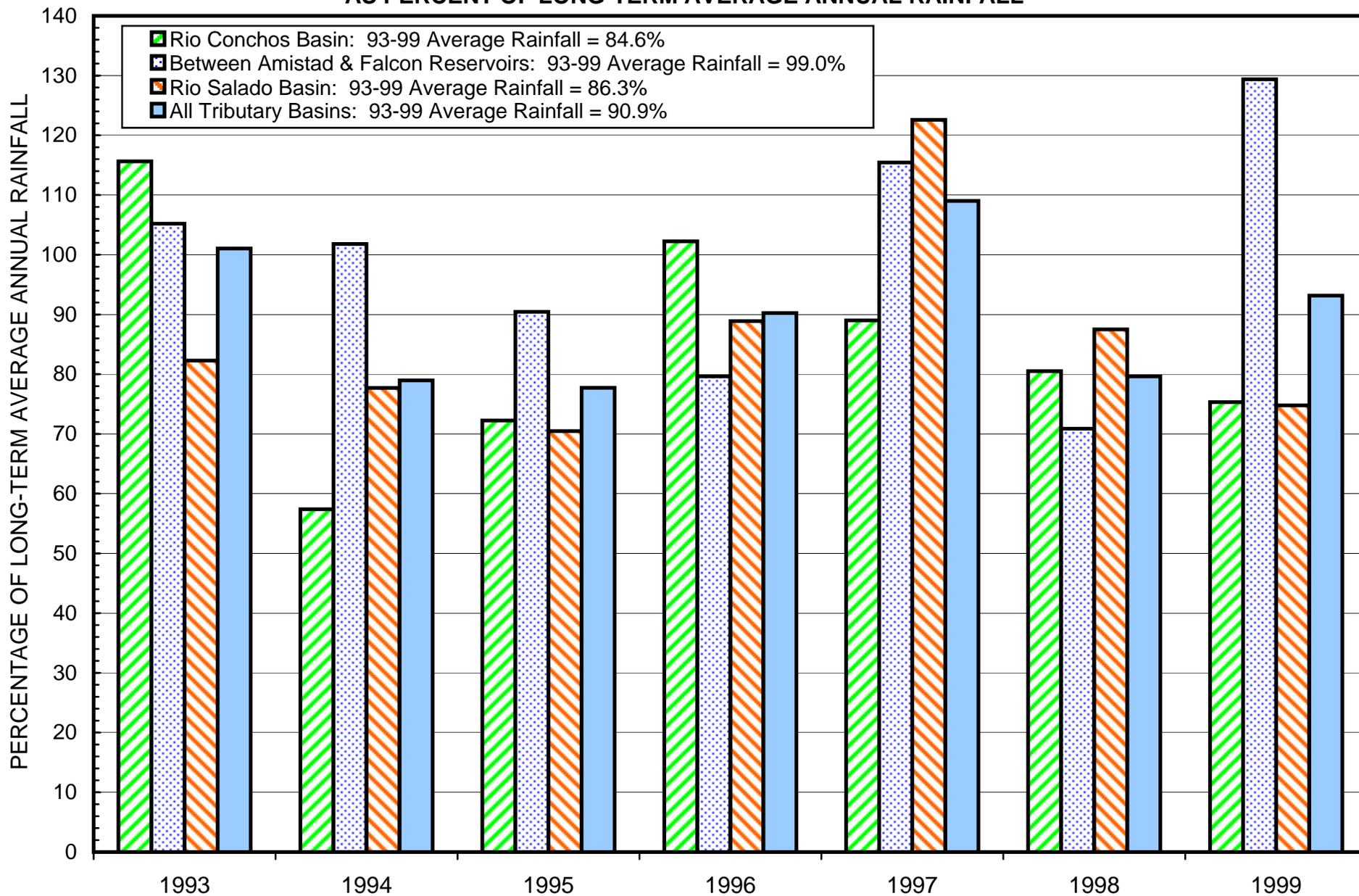
**FIGURE 9**  
**TOTAL MONTHLY INFLOWS TO BOQUILLA, MADERO AND CARRANZA RESERVOIRS**  
**OVER PERIOD OF COMMON DATA RECORDS**



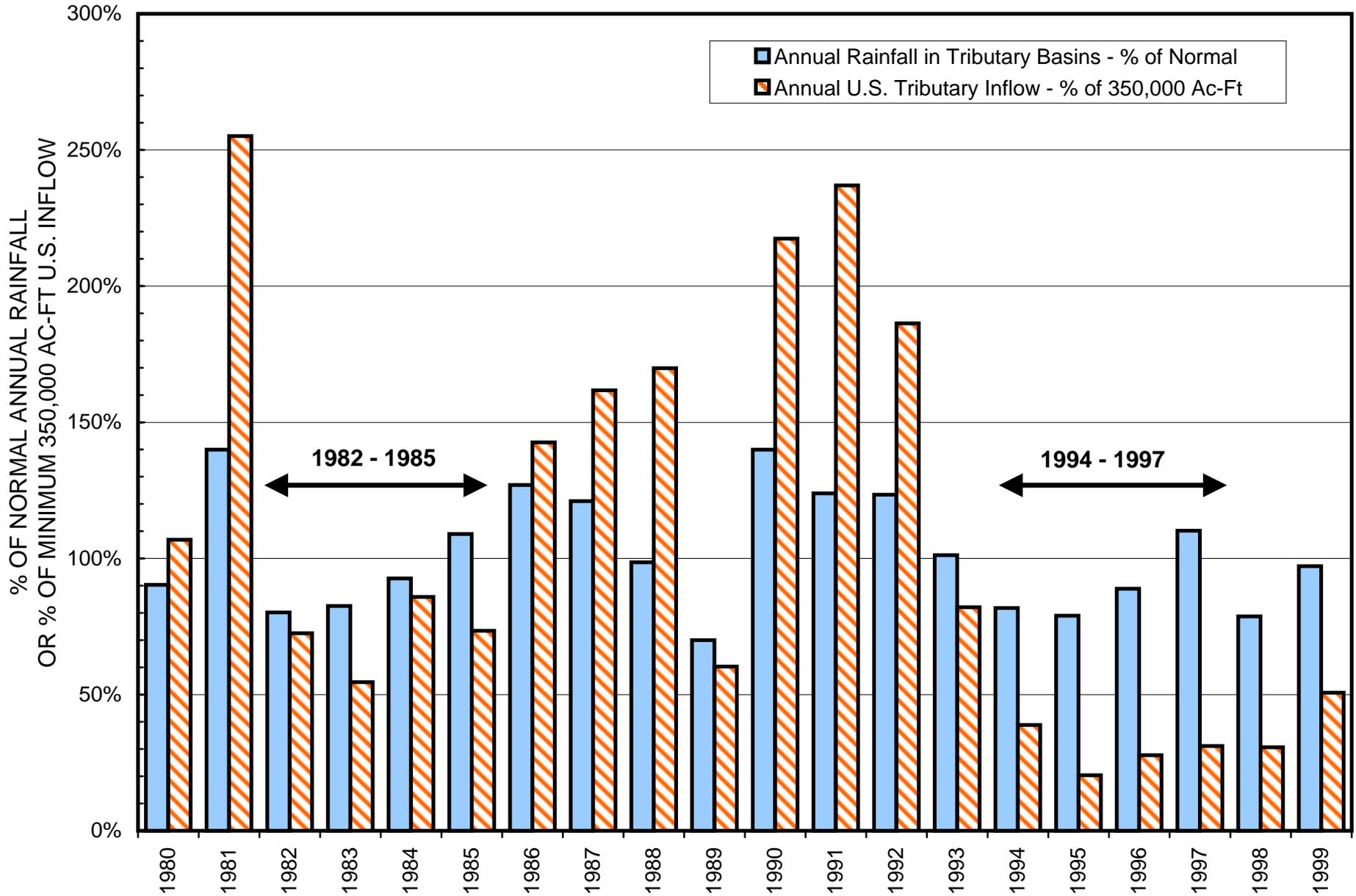
**FIGURE 10**  
**HISTORICAL END-OF-MONTH STORAGE IN LUIS LEON RESERVOIR ON THE RIO CONCHOS**



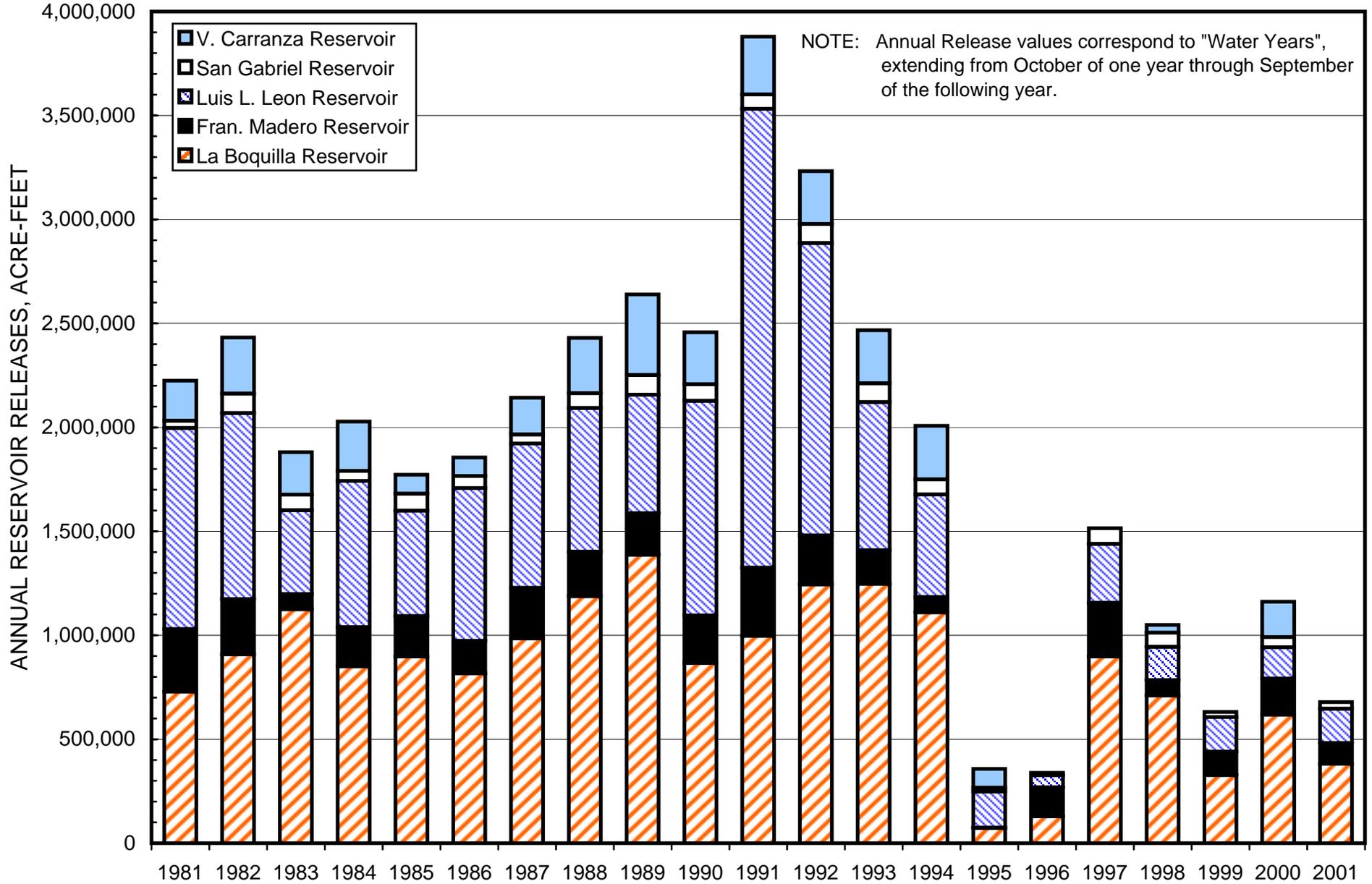
**FIGURE 11**  
**1993-1999 ANNUAL RAINFALL IN MEXICAN TRIBUTARY WATERSHEDS**  
**AS PERCENT OF LONG-TERM AVERAGE ANNUAL RAINFALL**



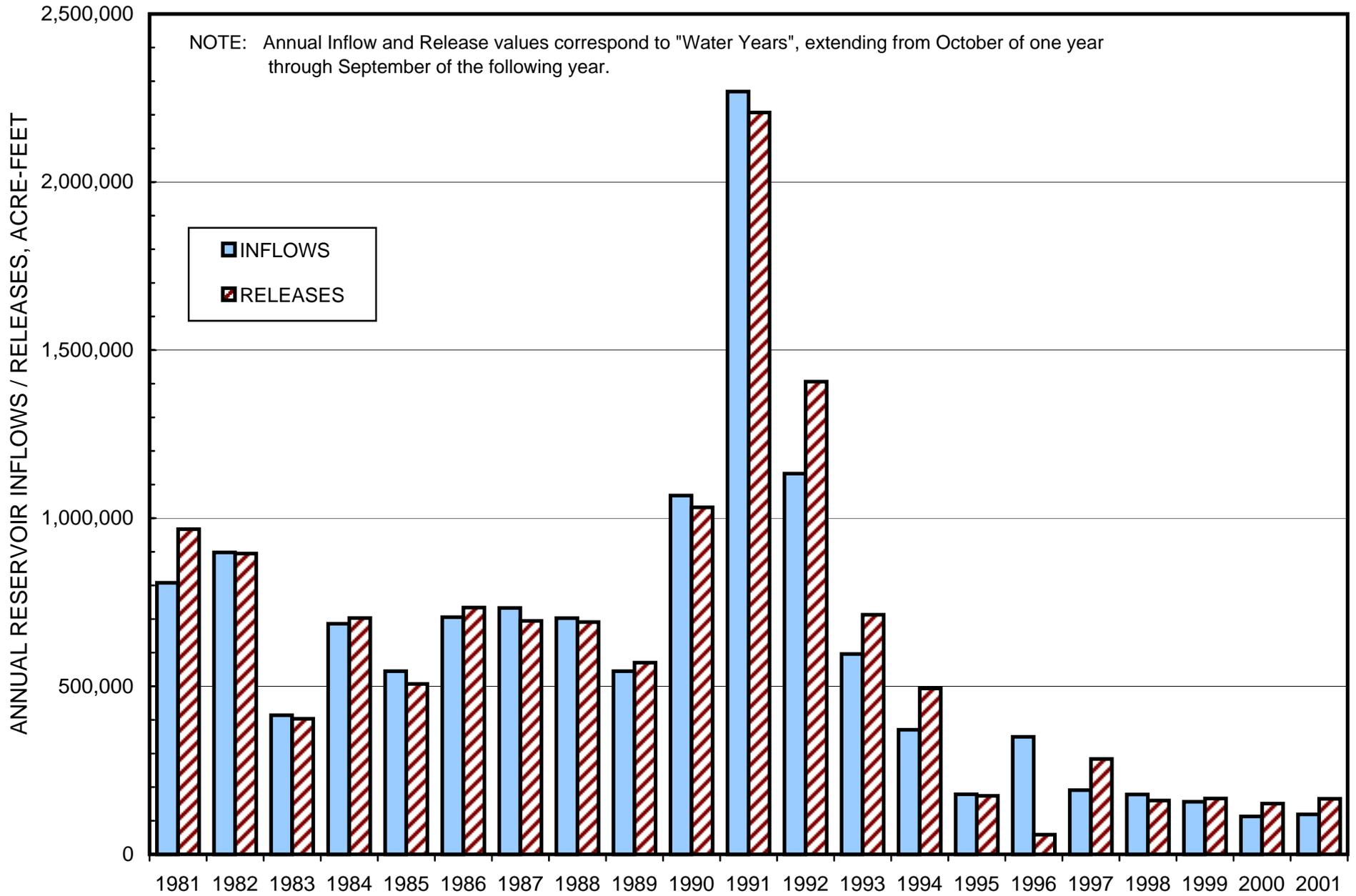
**FIGURE 12**  
**ANNUAL RAINFALL IN MEXICAN TRIBUTARY BASINS COMPARED WITH**  
**ANNUAL U.S. INFLOWS TO THE RIO GRANDE FROM MEXICAN TRIBUTARIES**



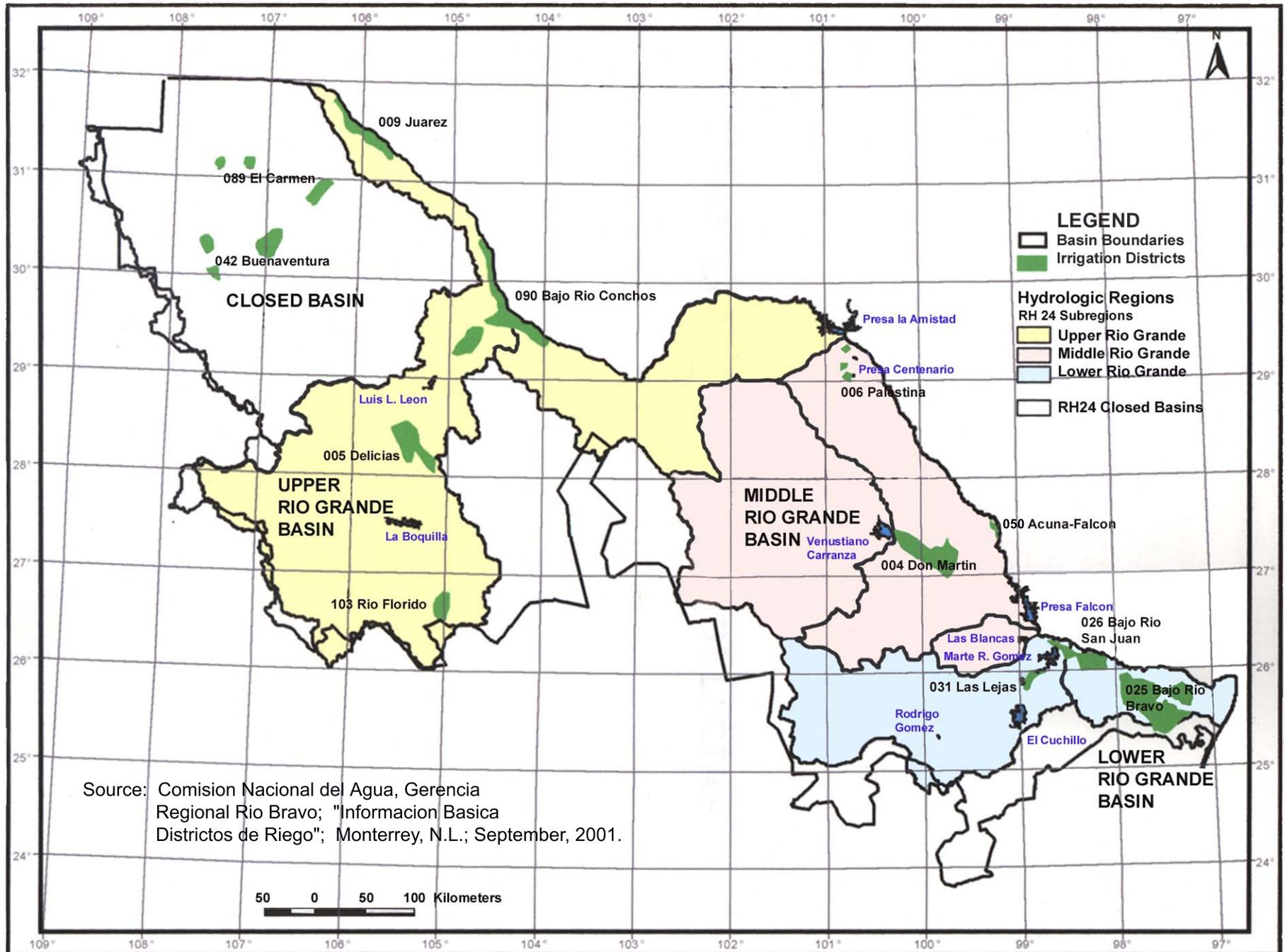
**FIGURE 13**  
**ANNUAL RELEASES FROM FIVE LARGEST MEXICAN RESERVOIRS**  
**LOCATED ON TRIBUTARIES IDENTIFIED IN 1944 TREATY**



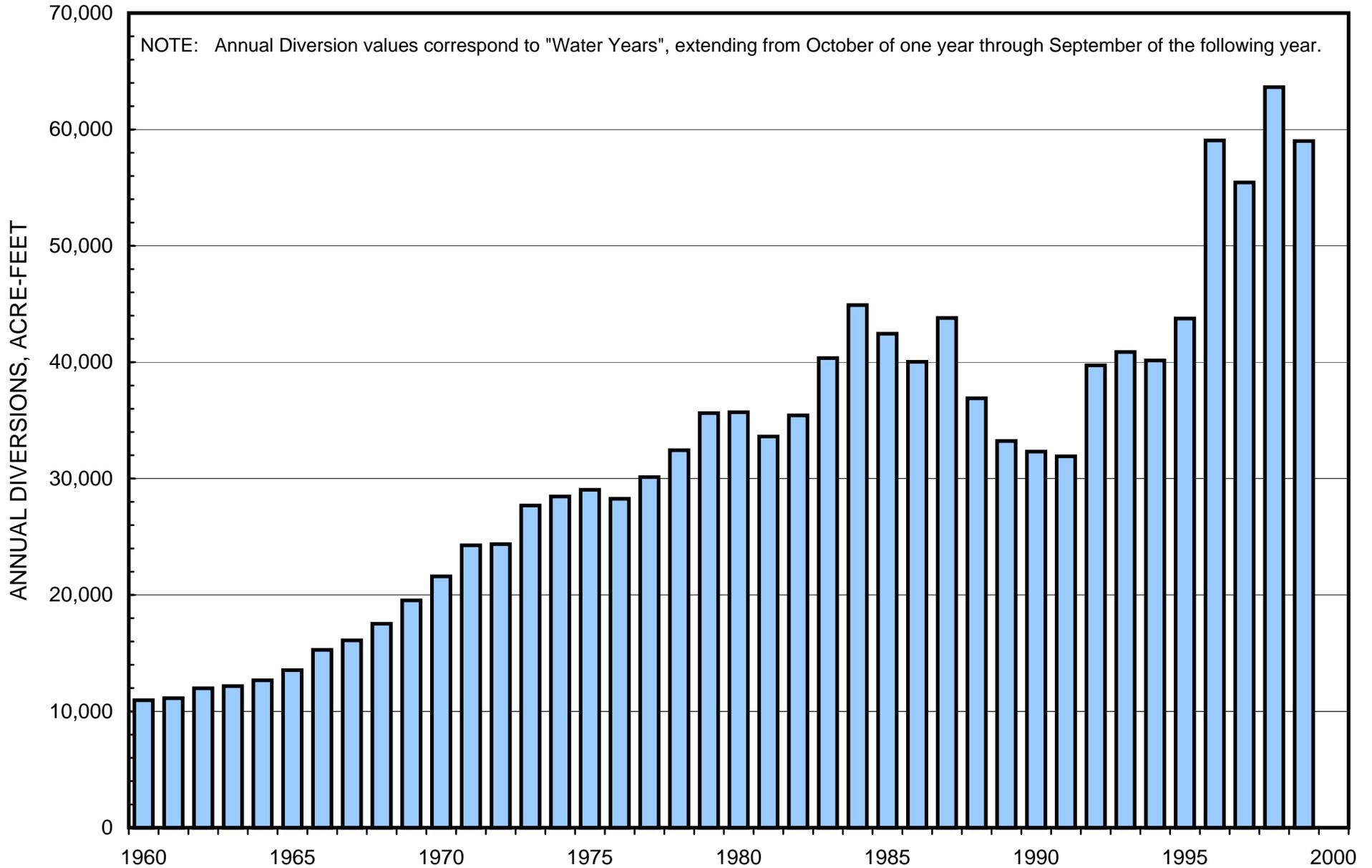
**FIGURE 14**  
**ANNUAL INFLOWS TO AND RELEASES FROM LUIS L. LEON RESERVOIR**



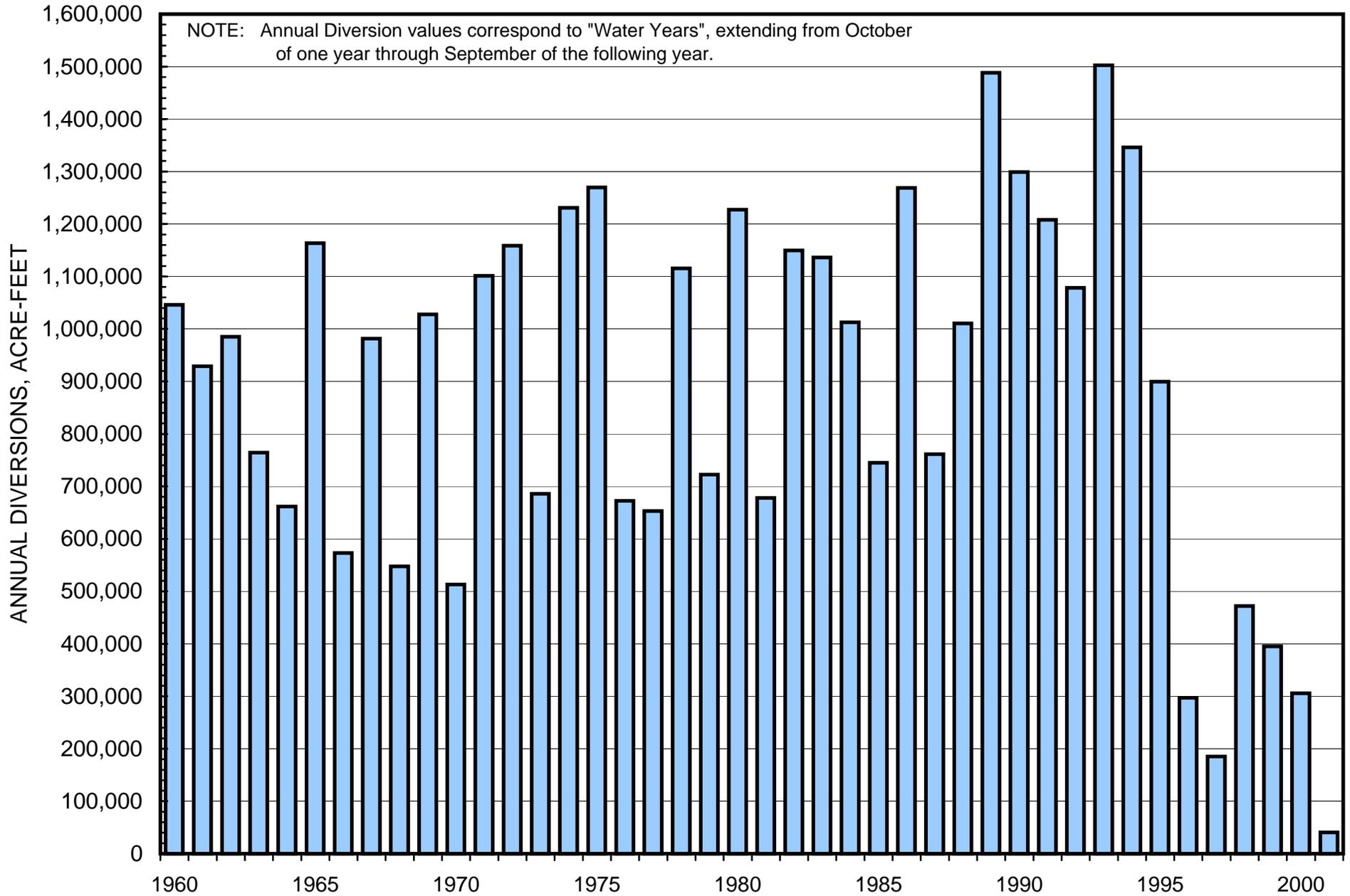
**FIGURE 15**  
**MEXICAN IRRIGATION DISTRICTS LOCATED IN RIO GRANDE BASIN**



**FIGURE 16**  
**ANNUAL DIVERSIONS FROM THE RIO GRANDE BY MAJOR MEXICAN MUNICIPALITIES**  
**BETWEEN AMISTAD AND FALCON RESERVOIRS**



**FIGURE 17**  
**ANNUAL DIVERSIONS OF MEXICAN WATER INTO ANZALDUAS CANAL**



## **TABLES**

TABLE 1  
MEXICAN RESERVOIRS IN TRIBUTARY BASINS IDENTIFIED IN THE 1944 TREATY

RIVER BASIN / RESERVOIR NAME	RIVER	STATE	YEAR CLOSED	STORAGE CAPACITY Acre-Feet
<u>RIO CONCHOS BASIN</u>				
La Boquilla	Rio Conchos	Chihuahua	1916	2,353,501
La Colina	Rio Conchos	Chihuahua	1927	19,538
Francisco I. Madero	Rio San Pedro	Chihuahua	1949	282,128
Chihuahua	Rio Chuiscar	Chihuahua	1960	21,079
Luis L. Leon	Rio Conchos	Chihuahua	1968	288,614
San Gabriel	Rio Florido	Durango	1981	206,732
Pico de Aguila	Rio Florido	Chihuahua	1993	40,536
Rio Conchos Basin Total Reservoir Storage Capacity:				3,212,127
<u>RIO SAN DIEGO BASIN</u>				
San Miguel	Rio San Diego	Coahuila	1935	16,214
Centenario	Rio San Diego	Coahuila	1936	21,322
Rio San Diego Basin Total Reservoir Storage Capacity:				37,536
<u>RIO SAN RODRIGO BASIN</u>				
La Fragua	Rio San Rodrigo	Coahuila	1990	36,482
<u>RIO SALADO BASIN</u>				
Venustiano Carranza	Rio Salado	Coahuila	1930	1,122,838
Laguna de Salinillas	Rio Salado	Nuevo Leon	1931	--
Rio Salado Basin Total Reservoir Storage Capacity:				1,122,838
TOTAL TRIBUTARY RESERVOIR STORAGE CAPACITY:				4,408,983

MEXICO'S SHARE OF MAJOR INTERNATIONAL RIO GRANDE RESERVOIRS

<u>RIO GRANDE BASIN</u>				
Falcon	Rio Grande	Tamaulipas	1953	1,098,674
La Amistad	Rio Grande	Coahuila	1969	1,380,278
TOTAL RIO GRANDE RESERVOIR STORAGE CAPACITY:				2,478,952

TABLE 2  
MEXICAN IRRIGATION DISTRICTS LOCATED IN THE RIO GRANDE BASIN  
WITH RELEVANCE TO THE 1944 TREATY MEXICAN WATER DEFICIT

NUMBER AND NAME OF IRRIGATION DISTRICT	STATE	RIVER SOURCE OF SUPPLY	ASSOCIATED RESERVOIRS PROVIDING WATER SUPPLY	YEAR OF INITIAL OPERATION	MAXIMUM IRRIGATED AREA Acres (Year)	NUMBER OF IRRIGATED TRACTS	MILES OF CANALS Primary/Secondary (% Lined)
005 Delicias	Chihuahua	Rio Conchos Rio San Pedro	La Boquilla F. Madero	1932	316,000 (1987)	9,509	99 / 880 (100% / 46%)
090 Lower Rio Conchos	Chihuahua	Rio Conchos	Luis Leon	1975	18,100 (1986)	1,156	69 / 69 (97% / 100%)
103 Rio Florido	Chihuahua	Rio Florido	San Gabriel	1980	14,100*	n/a	n/a
006 Palestina	Coahuila	Rio San Diego	Centenario San Miguel	1934	11,200*	1,427	n/a
004 Don Martin	Nuevo Leon	Rio Salado	V. Carranza	1931	69,200 (1989)	1,903	74 / 396 (0% / 24%)
050 Acuna-Falcon	Tamaulipas	Rio Grande	Amistad	1953	8,200*	n/a	n/a
026 Lower Rio San Juan	Tamaulipas	Rio San Juan Rio Alamo Rio Grande	Marte Gomez Las Blancas Falcon	1946	15,600 (1986)	4,787	121 / 538 (10% / 55%)
025 Lower Rio Bravo	Tamaulipas	Rio Grande	Falcon	1942	619,700 (1993)	15,158	263 / 1,198 (18% / 2%)

\* Represents average irrigated acreage, not maximum.

TABLE 3  
CROPS HISTORICALLY GROWN IN IRRIGATION DISTRICTS IN THE RIO GRANDE BASIN

( "X" denotes crop is grown )

SEASON	CROP	IRRIGATION DISTRICT				
		No. 005 Delicias	No. 090 Lower Rio Conchos	No. 004 Don Martin	No. 025 Lower Rio Bravo	No. 026 Lower Rio San Juan
FALL - WINTER	Wheat	X	X	X		
	Oats	X	X			
	Barley	X				
	Rye Grass	X	X			
	Vegetables	X				
	Forage			X		
	Misc.	X	X	X		
	Average Acreage Before 1992		75,760	5,683	17,653	0
Average Acreage 1993-2000		25,179	3,015	3,941	0	0
SPRING - SUMMER	Cotton	X	X		X	X
	Maize	X	X	X	X	X
	Sorghum	X		X	X	X
	Beans	X	X	X		
	Vegetables	X	X			
	Forage		X	X		
	Oily Plants		X			
	Misc.	X	X	X	X	X
Average Acreage Before 1992		111,564	5,757	33,646	472,249	174,008
Average Acreage 1993-2000		64,319	5,609	16,595	374,245	134,223
PERENNIALS	Pastures	X	X	X		
	Pecans	X	X			
	Alfalfa	X	X			
	Grapes	X				
	Oily Plants	X	X			
	Misc.	X				
	Average Acreage Before 1992		41,512	1,334	1,253	0
Average Acreage 1993-2000		31,999	4,472	2,011	361	0

TABLE 4  
HISTORICAL IRRIGATION DISTRICT OPERATIONS IN THE RIO GRANDE BASIN

IRRIGATION DISTRICT / PERIOD OR YEAR	TOTAL PRODUCTION AREA Acres	TOTAL IRRIGATED AREA Acres	VOLUME OF WATER USED Acre-Feet	CALCULATED IRRIGATION DEPTH Inches	CALCULATED APPLICATION RATE Acre-Feet/Acre
<u>District 005 - Delicias</u>					
Average Before 1992	228,836	228,836	1,180,504	62	5.2
1993	204,860	204,860	1,426,267	84	7.0
1994	197,173	197,173	1,126,599	69	5.7
1995	27,643	27,643	109,372	48	4.0
1996	49,442	49,442	257,074	62	5.2
1997	194,015	194,015	1,060,348	66	5.5
1998	128,735	128,735	733,863	68	5.7
1999	59,017	59,017	313,691	64	5.3
2000	110,971	110,971	660,104	71	5.9
Average 1993-2000	121,497	121,497	710,914	70	5.9
<u>District 090 - Lower Rio Conchos</u>					
Average Before 1992	12,775	12,775	81,071	76	6.3
1993	10,808	10,808	96,791	108	9.0
1994	10,981	10,981	86,049	94	7.8
1995	13,622	13,622	115,661	102	8.5
1996	7,764	7,764	42,169	65	5.4
1997	17,620	17,620	106,513	73	6.0
1998	14,764	14,764	92,459	75	6.3
1999	13,716	13,716	94,044	82	6.9
2000	15,565	15,565	87,515	68	5.6
Average 1993-2000	13,096	13,096	90,151	83	6.9
<u>District 004 - Don Martin</u>					
Average Before 1992	52,552	52,550	218,604	50	4.2
1993	57,427	57,427	254,681	53	4.4
1994	52,972	50,499	257,645	61	5.1
1995	19,628	16,615	91,191	66	5.5
1996	31,501	0	0	0	0.0
1997	25,776	0	0	0	0.0
1998	23,028	16,662	33,306	24	2.0
1999	30,409	0	0	0	0.0
2000	40,745	39,152	170,937	52	4.4
Average 1993-2000	35,185	22,548	100,971	54	4.5

TABLE 4, cont'd.  
IRRIGATION DISTRICT OPERATIONS IN THE RIO GRANDE BASIN

IRRIGATION DISTRICT / PERIOD OR YEAR	TOTAL PRODUCTION AREA Acres	TOTAL IRRIGATED AREA Acres	VOLUME OF WATER USED Acre-Feet	CALCULATED IRRIGATION DEPTH Inches	CALCULATED APPLICATION RATE AC-FT/ACRE
<u>District 25 - Lower Rio Bravo</u>					
Average Before 1992	584,335	472,249	725,205	18	1.5
1993	596,683	619,679	790,680	15	1.3
1994	564,690	564,067	784,353	17	1.4
1995	495,666	479,923	631,336	16	1.3
1996	460,271	211,675	171,956	10	0.8
1997	458,954	65,132	72,920	13	1.1
1998	490,037	465,762	393,137	10	0.8
1999	434,167	319,335	322,752	12	1.0
2000	449,369	271,253	261,075	12	1.0
Average 1993-2000	493,731	374,606	428,526	14	1.1
<u>District 26 - Lower Rio San Juan</u>					
Average Before 1992	184,551	174,008	333,908	23	1.9
1993	184,650	178,070	381,415	26	2.1
1994	187,783	182,545	375,342	25	2.1
1995	164,901	140,146	223,843	19	1.6
1996	147,915	144,426	20,681	2	0.1
1997	92,548	92,357	119,022	15	1.3
1998	155,555	148,268	180,534	15	1.2
1999	100,723	96,076	92,647	12	1.0
2000	91,901	91,898	89,260	12	1.0
Average 1993-2000	140,749	134,223	185,343	17	1.4